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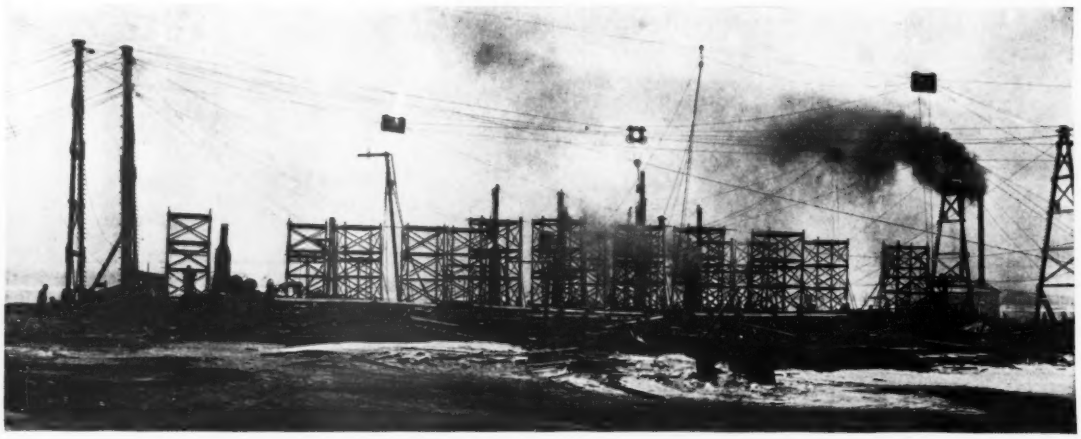


A novel method of constructing small, cylindrical open caissons of Lackawanna Steel Sheet Piling, as utilized in foundations for the new plant of the Buffalo General Electric Company

A timber pile was first driven on the location of the center of each pier, dressed at the top and a hole bored on its exact pier center. Excavation was then made around this center pile to near the water level and a lower templet set into position and secured to this center pile. An assembling tower of wood was then placed over lower templet and upper templet and guide ring centered in this tower in position over the lower templet.

Two cableways with two timber towers 70 feet in height, on skids and susceptible to being shifted readily, were constructed over the center lines of two rows of piers and were used to handle the steel sheet piling, steam pile driving hammers and wooden assembling towers, as shown above.

The steel sheet piling was assembled one bar at a time around the templets, the cableway being of sufficient height to raise the sheet piling bars above the 33-foot sheeting already assembled and permit the additional bars to interlock with the tops of assembled bars. The position of the cableways also permitted all of the piles in one cylinder to be assembled before driving any.

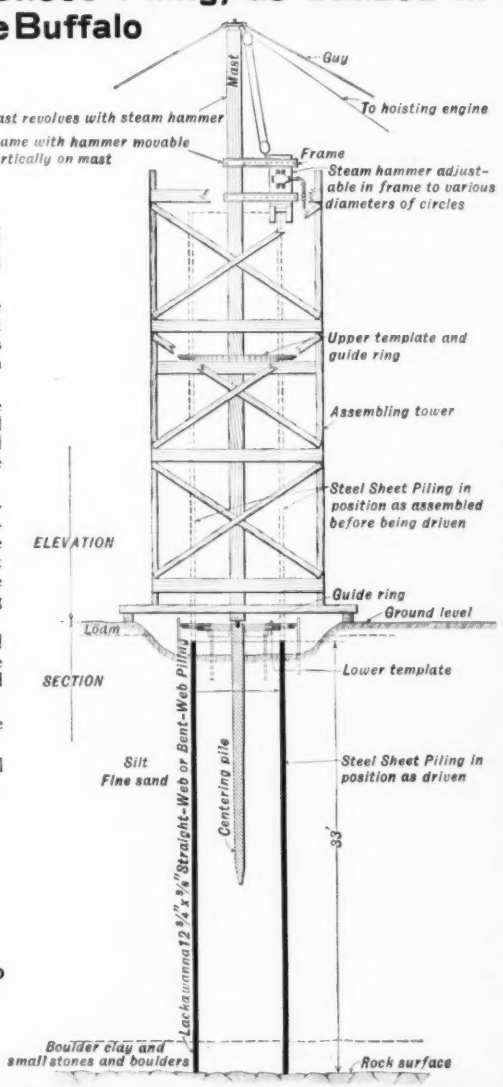
In other words, the entire cylinder could be set and held vertical and the closure pile assembled for its entire length. A 14 by 14-in. wooden mast 42 feet long and then mounted and held in position on top of the wooden pile by a 2-in. steel pin and guyed at the top by four $\frac{3}{4}$-in. wire cables, this mast being free to revolve within the top templet.

A 5,000-lb. steam pile-driving hammer was then raised by the cableway and supported from the mast by a frame of structural steel so designed as to allow the hammer and frame to slide freely upon the mast, and the mast being free to revolve, the hammer was offsetted from the mast just right to bring it central over the steel sheet piling to be driven. The driving hammer was lowered or raised by a set of double blocks provided on the side of the mast above the hammer, the power line passing over a shieve in the top of the mast to the stationary hoisting engine.

Two steel sheet piles were driven about 3 or 4 feet at a time by the hammer and the hammer raised and placed upon two adjacent piles, driving them about the same distance. This operation was repeated until the entire caisson was driven into bed rock.

Next week's advertisement will show some of these caissons and how they were utilized as permanent parts of the foundation.

If interested in foundation work you should have our book "Lackawanna Steel Sheet Piling" and you can also have our engineering advice for the asking



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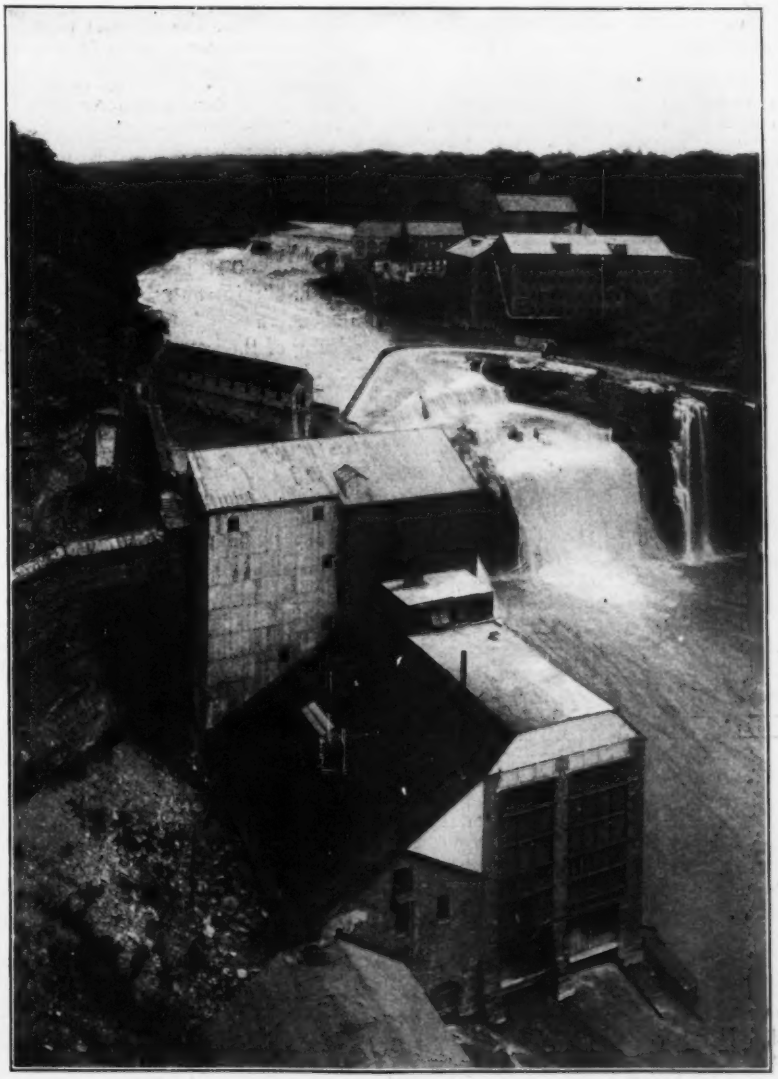
Engineering News

VOLUME 76 NOVEMBER 2, 1916 NUMBER 18

Developing More Water Power on Genesee at Rochester

A hydro-electric development, novel because made under unusual topographical conditions and also because it is made within the residential limits of a large city, is now under way by the Rochester Railway and Light Co. at Rochester, N. Y. The Genesee River in its flow through the city has four falls totaling 227 ft. in head, in addition to 22 ft. of intervening rapids. For some years the company has had two power developments at the two lower falls, known as station No. 5 at the lower falls and station No. 15 at the middle falls about 1,400 ft. upstream. The former station, shown in the foreground in Fig. 1, develops 8,800 hp. from the 94-ft. head by taking the water from behind a low diversion dam rounding the crest of the falls. The middle falls station, seen in the far background of Fig. 1 and also in Figs. 4 and 7, develops 2,700 hp. from the 27-ft. head by taking water from behind a gravity section concrete dam 6 ft. high.



LOOKING UP THE GENESEE RIVER FROM DRIVING PARK BRIDGE, ROCHESTER, N. Y.

Old Station No. 5 in foreground; Station No. 5 and site of new dam in far background

The new project consists in supplanting the upper dam by a new movable dam 16 ft. high which will elevate the pond 13 ft., and in building a tunnel carrying the water from this pond clear down to the face of the lower cliff, thus providing a low water head of 137 ft. in the new project, a gain of 13 ft., due to the extra head of the new upper pond and to the utilization of 3 ft. of rapids now wasted between the two falls. This increase of head and the increased efficiency of the new turbines increase the available power to about 20,000 hp. In addition the increase of height of the dam makes possible so large a storage behind it that for handling short peak loads the output may be raised to 48,000 hp. The new dam is made up of movable sections, as shown in Fig. 3, because the river is subject to flashy floods. Its maximum recorded flow is 45,000 cu. ft. per sec.; its minimum is 150 cu.ft. per sec., so that auxiliary steam power is required. When the new project is completed the old station No. 15 will be abandoned and the entire power concentrated in new station No. 5, old station No. 5 being removed. The data on the new development can best be appreciated by the following tabulation:

Turbine Installation—Estimated cost, $1,056,000 for present installation of 32,000 hp. Ultimate capacity of plant, 48,000

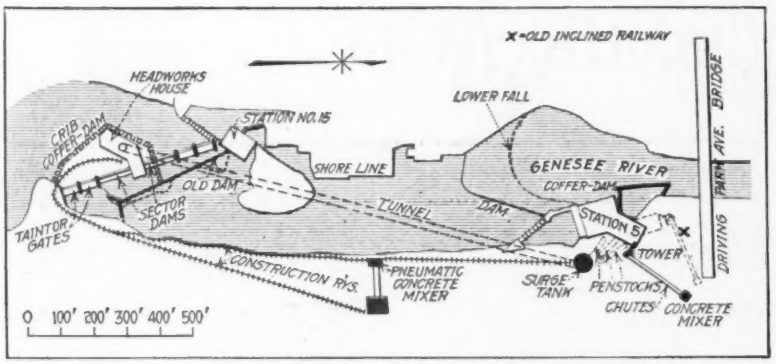


FIG. 2. PLAN OF NEW POWER DEVELOPMENT OF ROCHESTER RAILWAY AND LIGHT CO. ON GENESEE RIVER

hp. Turbines are I. P. Morris Co. vertical Francis type, developing 16,000 hp. at a head of 130 ft. Speed, 180 r.p.m. Weight of one turbine, 272,000 lb. Governors are I. P. Morris Co. double floating-lever governors, water operated. Weight of one governor, 43,000 lb.

Generators are Westinghouse 12,500-kv.-a., three-phase, 60-cycle, 11,500-volt. A combined efficiency of turbine and generator of over 88% is expected. Mounted on each generator is a 250-volt 100-kw. direct-connected exciter. It requires 57,500 cu.ft. of air per min. to cool each generator at full load. The rotating parts of the exciter, generator and turbine and the hydraulic thrust of the turbine are carried by a Kingsbury bearing capable of supporting 100 tons.

Power House—Reinforced-concrete and steel building. Present length, 90 ft. Will be increased to 125 ft. when third unit is installed. Width, 75 ft. Height, 112 ft. above rock. Will serve as a generating and substation and replace old Stations Nos. 5 and 15.

Valves—Flow of water is controlled by Johnson valves contained in the penstock. These valves serve as venturi meters for measuring the flow of water.

Penstocks—Three penstocks are carried out of the rock. One is closed off with a steel bulkhead. These are 13 ft. in diameter and built of ¾-in. plate. They extend about 30 ft. into solid rock.

Tunnel—Horseshoe shape. Area, 317 sq.ft. Capacity, 3,900 cu.ft. per sec., with a velocity of 12.3 ft. per sec.

Dam—Movable steel structure with concrete base and piers. Total length of spillway, 400 ft., made up of four Taintor gates each 50 ft. long and 16 ft. high and two sector gates each 100 ft. long and 16 ft. high. Each Taintor gate weighs 40 tons. Each Taintor gate hinge weighs 3 tons, two hinges to each gate. Each sector gate weighs 150 tons. Each sector gate hinge weighs 90 tons, being continuous and 100 ft. long.

Intake—Located in center of river. Has 16 openings 10 ft. wide by 12 ft. high, eight on each side of building; controlled by steel gates operated by traveling electric hoist from above. Rubbish kept out by outer curtain wall which extends 4 ft. below low water and by steel trash racks inside building.

Pond—Total storage from El. 375.5 to El. 390 equals 23,000,000 cu.ft. of water, which will produce 25,000 kw.-hr. of energy.

Surge Tank—A steel-plate differential surge tank 60 ft. in diameter, 48 ft. deep, with riser 18 ft. in diameter, built under R. D. Johnson's patent.

Construction Work To Be Done

The construction elements of the new development consist in the erection of a new movable dam at the middle falls, the driving of a shaft in the river at that point and a tunnel 1,400 ft. long to the face of the cliff at the lower falls, the sinking of a surge tank shaft just above the lower falls but in the bank to the east of the river and the building of the power plant alongside of old station No. 5 at the lower falls.

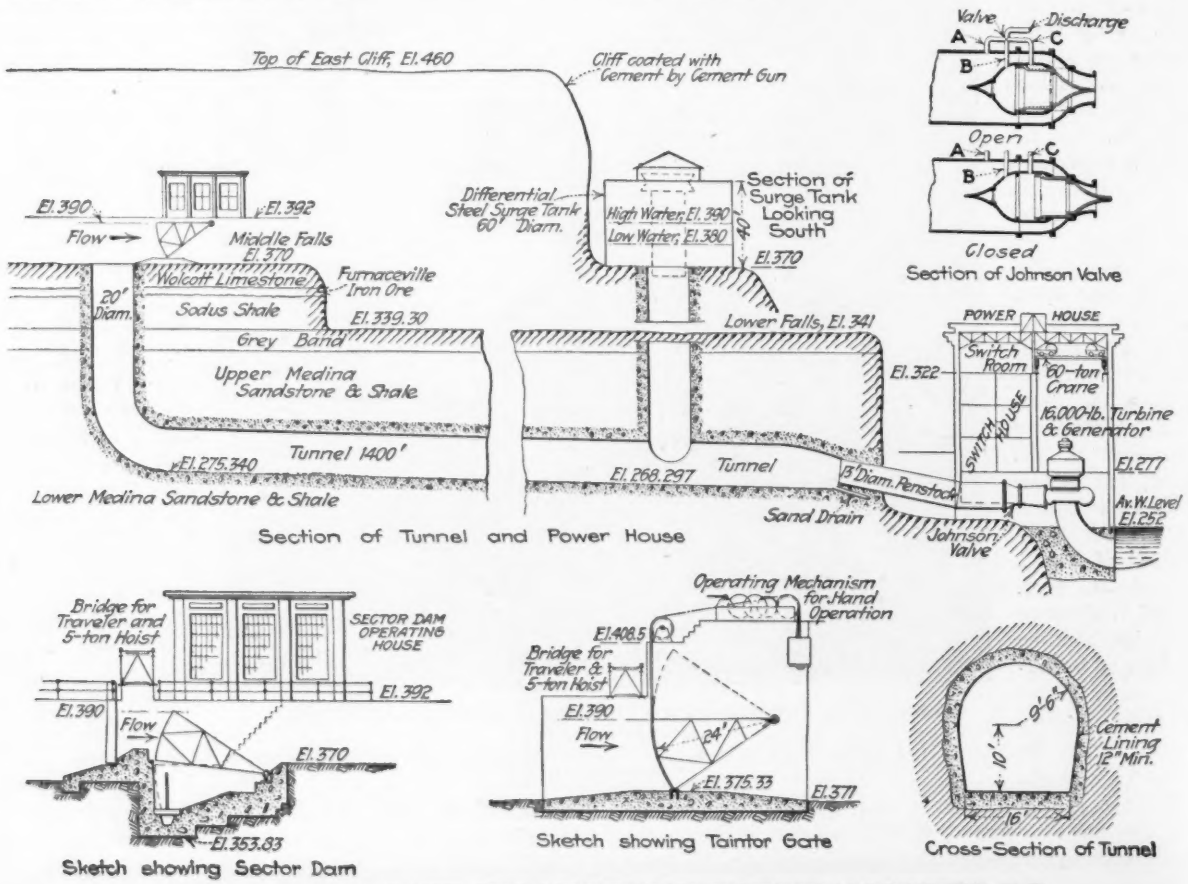


FIG. 3. DETAILS OF NEW HYDRO-ELECTRIC DEVELOPMENT AT ROCHESTER, N. Y.

FIG. 4. COFFER-DAM JUST PLACED AT MIDDLE FALLS

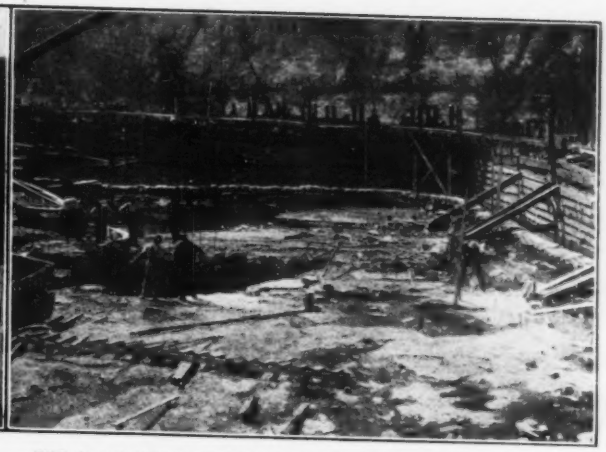


FIG. 5. SINKING INTAKE SHAFT BACK OF COFFER-DAM

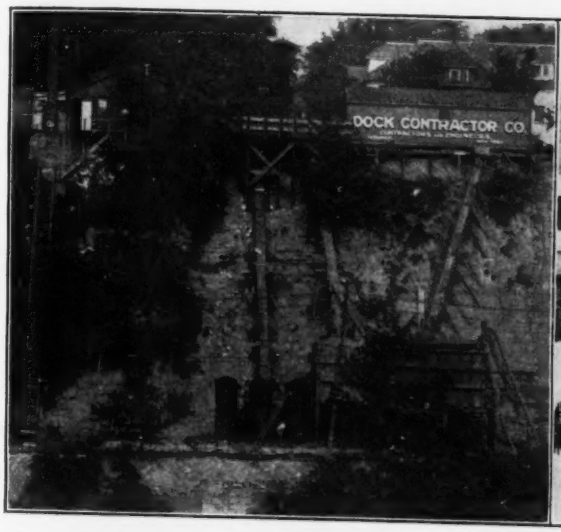


FIG. 6. CONCRETING PLANT ON EAST CLIFF OF RIVER

FIG. 7. LOOKING DOWN RIVER FROM MIDDLE FALLS

FIG. 8. NEARER VIEW OF CONCRETING TRESTLES

FIG. 9. BEGINNING WORK AT STATION NO. 15

The operations now in progress comprise the construction of the east half of the dam behind a coffer-dam shutting off that part of the river, the driving of the tunnel southward from the surge tank shaft already completed and the erection of the power station. It is intended to complete one-half of the dam in the present season and to complete the tunnel by carrying it through from the north end to the intake shaft to be sunk behind the coffer-dam already in at the middle falls.

The further progress of the work is not decided upon but it is thought that the station will be completed and allowed to take water from the finished half of the dam

before throwing old station No. 15 out of service and building the remainder of the dam behind a coffer-dam cutting off the river clear across to the west bank. The scheme of operations depends upon the stage of the river at the time of "cutting in on the line."

Construction operations were somewhat handicapped by the topography, although the height of the top of the gorge permitted the economical use of gravity chutes from the city streets, ending right at the gorge edge, to the work below. It was necessary, however, to do some extensive cutting to locate the construction railway along the east bank of the river.

Coffer-Dam at Middle Falls

The preliminary work at the middle falls was the construction of the coffer-dam. This was built of cribs formed from old freight-car sills—a common timber material in this locality. These cribs, each 10x16 ft. in plan were built on shore, floated out in proper line and sunk by filling with rip-rap. When lined up they were connected by an upper and lower line of old freight-car beams which acted as waling pieces against which to drive wooden sheeting, which took fairly good hold in the thin mud covering to the rock bottom. This dam, shown from the inside in Fig. 5 and also in Figs. 4, 7 and 8, has proved quite tight enough for all practical purposes. With the aid of minor defenses of sand-bag dams and emergency pumps, it has held the maximum 15 ft. head throughout the summer. Behind it have been built the piers for the dam and the head-house structure. The intake shaft was also started, as shown in Fig. 5, with the possibility in mind of working the tunnel from both ends but this idea has since been abandoned.

Material is brought down to the river bed on narrow-gage cars with cable control, the track extending down from the mixing plant at Avenue B to the junction with another line leading to the surge-tank location.

Novel Pneumatic Concreting System Employed

The concreting of the dam and head house is being carried on with a pneumatic mixer and conveyor taking material as chuted down the cliff and shooting it about 1,150 ft. to distribution trestles over the work. The novelty of the scheme lies in the fact that the concrete materials—cement, sand and gravel—are shot dry from the mixer to within 100 ft. of the point of delivery where water is added through a nozzled sleeve. This machine is the invention of Alexander Jensen, 2 Rector St., New York City, and has never before been used on any extensive work. Mr. Jensen claims that the dry materials are carried through the pipe with far less resistance than wet concrete so that much less aid is required for the work.

The concreting plant is shown in Fig. 6. Material is delivered by wagon at the foot of Avenue B (see map Fig. 2) and is dumped down chutes to the storage house over the mixer. It was hoped at the beginning of the work to be able to use the rock taken from the work in the concrete and for that purpose a crusher and screen were installed at the mixer. This rock proved too soft and crumbly for the purpose and that part of the plant has been abandoned, gravel brought in by wagon being used instead. The compressor plant is located on top of the cliff and three storage tanks alongside of the mixer house feed the pipe line at about 85-lb. pressure.

From the mixer an 8-in. flanged wrought-iron pipe-line is carried along the base of the cliff to the site, where it is led to various parts of the work on the trestles shown in the views. The water is added just before the pipe reaches the trestle through a sleeve pierced with nozzles connected to the city water-supply, under about 75-lb. head, 30 lb. of which is due to the drop from the water main on the upper street level. The concrete starts in the pipe under about 85 lb. at pressure but this drops to near 60 lb. at the water entrance and to about 55 lb. at delivery. The work started with a supply of ½ cu.ft. of air to each 1 ft. of pipe line but this has since been increased to ¾ cu.ft. per 1 ft. of line. The water is controlled by a man at the sleeve who adds it according to judgment when he hears the roar and rattle of the charge approaching through the pipe. This judgment is controlled by the appearance of the delivered mix. Each charge is ⅓ cu.yd.

At the delivery end the mixed concrete is dropped into a box where, when necessary, it can be stirred up into a more thorough mix, and is then chuted to proper locations.

A great deal of trouble has been experienced with wear of the pipe not only on the bends which frequently require replacement but even on the straight line. Clogging of the pipe line, with consequent necessary removal of the clogged section, and inadequate mix at the delivery box, has also occurred at times.

At the lower falls the work to be done consists in the construction of the new power house with the connecting penstocks to the tunnel which emerges from the face of the cliff just above the power house. This required the demolition of an old unused building just below the old station, the clearing of the talus which shows clearly in Fig. 1 and the erection of the new station partly on the rock so cleared and partly on rock formerly under water below the old station. For this latter work a small coffer-dam of crib construction similar to that used at the middle falls but built right in place was set up early in the summer and the excavation for the new tail-race by steam shovel sending spoil by cable car down the gorge is now under way back of the coffer.

All material for this part of the work is brought in by an old inclined railway (Fig. 9) leading down from the street level above. This railway, however, is not large enough for the future needs of the station, and a new one 280 ft. long, on an angle of 42½° is to be built with a capacity of 40 tons. The concrete for the station is mixed by a rotary mixer located alongside the top of the incline and is distributed by an Insley chute to wherever required.

Driving the Tunnel

The tunnel, details of which are shown in Figs. 2 and 3, is 1,400 ft. long and of horseshoe section, nearly equivalent to a circle 20 ft. in diameter, that is 317 sq.ft. It has a capacity of 3,900 cu.ft. per sec. with a velocity of 12.3 ft. per sec. It is being driven through Upper Medina sandstone and shale, a formation of sufficient solidity to dispense with timbering except at isolated places where there is considerable scaling. Work is being prosecuted entirely from the surge tank shaft toward the middle falls, though the short section to the north has already been opened and is used for ventilation and to carry out small quantities of rock for plums in the power house concrete. The main spoil, however, is carried back from the face to the shaft where an elevator takes it to cars on the construction railway along the river edge. These cars deposit the spoil along the shore just above the middle falls.

The tunnel is being driven in full-width heading, with a bench of about 13 ft. which is carried along with each shot. Mucking is done with a Thew shovel, electrically driven, which runs on rollers and is of such radius that it can be readily dig into the bench spoil and turn inside the tunnel to deposit the muck in waiting mule-cars on a narrow-gage track. This shovel has a special swivel joint on the bucket so that the bucket will turn sidewise when it hits an immovable piece of rock, thus obviating the danger of blowing a fuse from overload, a common trouble with electric shovels. The bucket is 5/8 cu.yd. capacity.

The tunnel is to be lined with concrete behind Blaw steel forms, but the method of mixing and depositing the concrete has not been decided upon.

The cliff face above the surge-tank shaft and the new station was badly weathered and subject to dangerous rock falls. Preliminary to any work there the whole face was cleaned with a high-power hydraulic jet and subsequently was covered with about ½ in. of cement mortar applied with a cement gun, devised by Alexander Jensen, who also is the inventor of the concreting machine used in the dam. This surfacing of mortar follows closely the irregularities of the rock face and resembles in appearance the saline deposits in a cave, but it seems to consolidate the rock face and to prevent the small rock falls which might cause trouble after the plant is complete.

Engineers and Contractors

The whole project described herewith is under the direction of James T. Hutchings, General Manager of the Rochester Railway and Light Co. Franklin J. Howes is Chief Engineer of the company and Frederick W. Fisher, Field Engineer. Charles M. Whelan is in charge of the design of the hydraulic work; the movable dams are under Edgar R. Crofts and the electrical features under Walter S. Burch. Norman H. Guinter is Resident Engineer. The entire contract is held by the Dock Contractor Co., of Hoboken, N. J., of which W. V. McMenimen is vice-president and general manager, and William G. Thompson, superintendent.

Experiments with Submerged Orifices and Tubes

By T. C. Rogers* and T. L. Smith†

The subject of this paper was suggested by a paper by C. B. Stewart, on "The Flow of Water Through Submerged Tubes; Results of Experiments at the University of Wisconsin," published in *Engineering News*, Jan. 9, 1908. In his experiments only one size of orifice was used, a 4-ft. square, and the entrance conditions and length of tube were varied. No experiments were made with heads of more than 0.4 ft.

In the experiments herein described, three sizes of orifices were used, 6-, 8- and 10-in. squares; and the length of tube was varied, but square edges at entrance were used throughout. Heads up to 2.2 ft. were employed.

Although these two investigations were carried on under somewhat different conditions, the results agree very closely and seem to indicate that for submerged square tubes with square edges at entrance there is a definite law, hitherto unknown, regarding the relation between length of tube and coefficient of discharge.

*American Telephone and Telegraph Co., New York City.

†Instructor in Civil Engineering, Cornell University, Ithaca, N. Y.

Equipment for Experiments

The experiments were made at the hydraulic laboratory of Cornell University, located in Fall Creek gorge below Beebe Lake, which furnished an abundant gravity supply of fresh water. The water is taken from the lake through a 48-in. pipe and thence delivered to the testing flume through a 10-in. pipe, under about a 40-ft. head. Control is by a 10-in. gate valve. The testing flume is of concrete with walls 4 in. thick. It is 2 ft. wide, 4 ft. deep and 26 ft. long. The details are shown in Fig. 1. The galvanized-iron baffles in the flume near the supply pipe caused the water to approach the orifice without eddies. Surface commotion was reduced by a wooden float, 3 ft. long, placed downstream from the baffles.

The bulkhead containing the orifice and tube was located 10 ft. downstream from the nearest baffle, the arrangement being shown on Fig. 1. The planks of the bulkhead were tongue-and-groove 3 in. wide, 1¾ in. thick and surfaced on the upstream face. The bulkhead was thoroughly calked, and no leakage could be detected.

The orifices, except the sharp edge, for the three different sizes were cut out of a clear white-pine plank 12 in. wide, 2 ft. long and 1¾ in. thick, surfaced on both

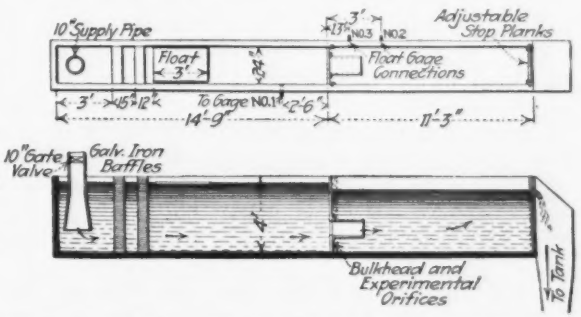


FIG. 1. ARRANGEMENT OF FLUME FOR EXPERIMENTS ON SUBMERGED ORIFICES AND TUBES

sides. Care was taken to keep the edges square. The tubes were constructed of clear white-pine boards, ¾ in. thick and surfaced on both sides. After being fitted accurately to their respective orifices, the tubes were held in position by cleats. The long tubes were braced at the top and bottom 1 ft. from the exit.

The sharp-edge orifices were cut out of No. 26 galvanized-iron plates, 2 ft. square. The edges were made uniform and smooth by finishing them with a fine file.

At the exit end of the testing flume, 11 ft. 3 in. downstream from the orifice, there was constructed a second bulkhead of stop planks. These planks were 3 in. wide and could be removed one at a time, thus facilitating an easy change of head on the downstream end of the flume. After passing over the stop planks the water was led through a galvanized-iron downspout by means of which the flow could be diverted either into the measuring tank or into a waste pipe.

Three float gages were used to determine the height of water in the flume. Gage 1 was situated 2 ft. 6 in. above the bulkhead. Gage 2 was 3 ft. below the bulkhead; and Gage 3 was 1.3 ft. below the bulkhead. The

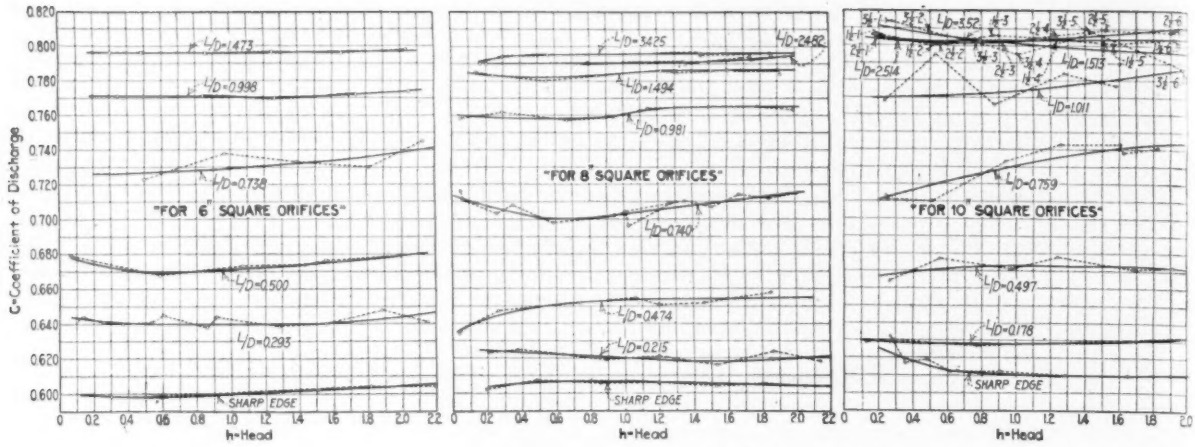


FIG. 2. RESULTS OF EXPERIMENTS WITH SUBMERGED ORIFICES AND TUBES

connections of the gages to the flume were ¾ in. in diameter. The gages read to 0.001 ft.

The measuring tank had a capacity of 400 cu.ft. It was constructed of concrete and was provided with a float gage which gave cubic feet directly. The gage read to 0.1 cu.ft.

General Method of Making Observations

The program followed was uniform throughout the experiments. Observer No. 1 adjusted the flow by removing or replacing stop planks and by varying the supply of water. After the water on both sides of the orifice had very nearly reached the desired levels, sufficient time was allowed to elapse for the flow to become steady. No. 1 then signaled to No. 2. No. 2, after a warning signal, diverted the flow into the measuring tank. When the tank was nearly full, No. 2 gave another warning signal and diverted the flow into the waste pipe.

During the filling of the measuring tank all three gages were read. The level of water in the tank was read before and after, a correction applied from a calibration table, and the total quantity determined in this way.

The time was observed in two ways. For runs of less than 2 min. duration, a chronograph, an electric bell and several batteries were connected in series with the diverter so that as the water was diverted into the tank and out of the tank, an electric circuit was made. The completion of the circuit rang the bell sharply and indicated the instant of diversion on the chronograph tape. The chronograph was connected to a seconds pendulum, thus giving a mark on the tape each second. The tape ran at a fairly uniform rate and time was read to 0.01 sec. The bell was used to check the chronograph time. Observer No. 1 noted the time of each ring to the nearest fifth of a second, using a watch with a sweep-second hand. For runs of more than 2 min., the chronograph was omitted and the time was taken by observer No. 1. He was checked to the nearest second by No. 2.

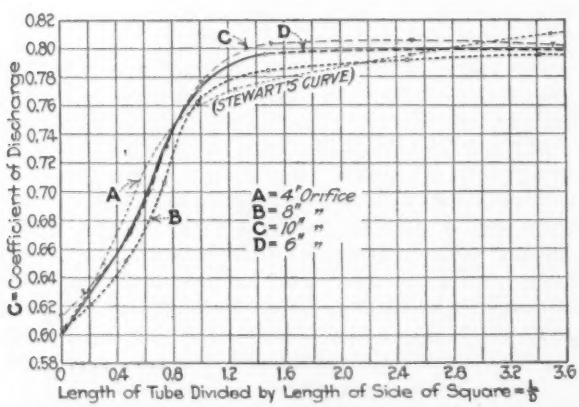


FIG. 3. CURVES SHOWING EFFECT OF CHARGING LENGTH OF ORIFICE TABLES
From experiments by Rogers and Smith and C. B. Stewart

TABLE 1. ORIFICE-AND-TUBE COEFFICIENTS FOR VARIOUS HEADS

Values taken after averaging curves of Fig. 2

Length of Tube Divided by Side of Square, L/D	Head in Ft. 0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	Average Coefficient
6-In Orifice											
Sharp edge	0.599	0.598	0.598	0.598	0.600	0.601	0.601	0.602	0.603	0.604	0.600
0.293	0.642	0.641	0.640	0.640	0.640	0.640	0.640	0.641	0.642	0.644	0.641
0.500	0.675	0.671	0.669	0.670	0.671	0.672	0.674	0.675	0.677	0.679	0.673
0.738	0.726	0.726	0.727	0.728	0.829	0.731	0.732	0.734	0.736	0.738	0.729
0.998	0.771	0.771	0.771	0.771	0.770	0.770	0.771	0.771	0.772	0.774	0.771
1.473	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.797	0.797	0.797	0.796
8-In. Orifice											
Sharp edge	0.603	0.605	0.607	0.607	0.607	0.606	0.606	0.605	0.605	0.604	0.605
0.215	0.624	0.623	0.622	0.621	0.620	0.619	0.618	0.618	0.619	0.620	0.621
0.474	0.643	0.648	0.651	0.653	0.653	0.654	0.654	0.654	0.655	0.655	0.652
0.740	0.707	0.703	0.700	0.701	0.703	0.705	0.708	0.710	0.713	0.715	0.706
0.981	0.759	0.758	0.758	0.759	0.760	0.764	0.765	0.765	0.765	0.765	0.762
1.494	0.783	0.782	0.782	0.783	0.784	0.786	0.786	0.786	0.786	0.786	0.784
2.482	0.790	0.790	0.790	0.790	0.790	0.790	0.790	0.791	0.793	0.795	0.795
3.425	0.792	0.795	0.795	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.795
10-In. Orifice											
Sharp edge	0.625	0.618	0.613	0.611	0.610	0.610	0.610	0.610	0.610	0.611	0.613
0.178	0.629	0.628	0.628	0.628	0.628	0.629	0.629	0.629	0.630	0.632	0.629
0.497	0.666	0.669	0.671	0.672	0.673	0.673	0.673	0.673	0.672	0.671	0.671
0.759	0.711	0.716	0.721	0.726	0.731	0.735	0.738	0.741	0.743	0.744	0.731
1.011	0.770	0.770	0.771	0.772	0.774	0.776	0.778	0.781	0.784	0.787	0.776
1.513	0.805	0.803	0.803	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.803
2.514	0.804	0.802	0.802	0.801	0.802	0.804	0.805	0.807	0.809	0.811	0.805
3.520	0.811	0.808	0.805	0.803	0.801	0.800	0.799	0.798	0.796	0.797	0.802

Conclusions

Curves were plotted between discharge coefficient and head for each length of tube (Fig. 2) and also between average discharge coefficient and length of tube (Fig. 3), the latter being expressed as the ratio of tube length L to the side of the square orifice D.

The curves plotted showing variation of discharge coefficient with head indicate that in most cases there is a slight increase in coefficient with higher heads.

This increase is not pronounced, however, except in one or two curves, and in some cases there seems to be a decrease in the coefficient with higher heads. At any rate there is no definite form that will fit all the curves. Some are nearly straight horizontal lines while others rise rapidly, or dip in the middle. Most of the observations give good lines, but in some cases (and this is more apt to be so with $L/D = 0.50$, 0.75 and 1.00) the points seem to be scattered about the diagrams irregularly.

From the head-coefficient curves, Table 1 was prepared, giving coefficients for every 0.2 ft. up to 2 ft. The average of these was used in plotting the curves between L/D and discharge coefficient C.

All the curves between L/D and C seem to have the same general form, the coefficient rising rapidly with an

TABLE 2. ORIFICE-AND-TUBE COEFFICIENTS FOR VARIOUS LENGTHS OF PIPE

Length of Tube Divided by Side of Square, L/D	Rogers and Smith Heads 0.2 to 2 Ft. 6 In. Sq.	8 In. Sq.	10 In. Sq.	Average	C. B. Stewart, 4 Ft. Sq.	Average of Four Sizes of Orifice
Sharp edge	0.600	0.605	0.613	0.606	0.604	0.605
0.25	0.635	0.625	0.637	0.632	0.640	0.634
0.50	0.673	0.657	0.672	0.667	0.692	0.674
0.75	0.732	0.710	0.730	0.724	0.739	0.728
1.00	0.771	0.764	0 775	0.770	0.760	0.767
1.50	0.796	0.784	0.803	0.794	0.777	0.790
2.50	0.799	0.791	0.805	0.798	0.795	0.797
3.50	0.799	0.795	0 802	0.799	0.810	0.802

increased length of tube $L/D = 1.5$, after which there seems to be very little increase. The greatest discrepancy between any two of the curves is between the 6- and 8-in. orifices at $L/D = 0.75$. The discrepancy here is only 3%. These curves, together with C. B. Stewart's curve of the same nature for orifices 4 ft. square, are shown in Fig. 3.

Table 2 was prepared, showing the coefficients for all four orifices for $L/D = 0$, 0.25, 0.50, 0.75, 1.00, 1.50 2.50 and 3.50. Average coefficients were taken using only the orifices experimented on in the present investigation. The greatest discrepancy between an individual observation and the averages (with one exception) is 3.8%. Another set of averages was taken, including Mr. Stewart's coefficients. The greatest discrepancy from these averages for a curve is 3.2% (Stewart's curve), and for an individual observation 4.4%.

The general conclusion may be drawn from these experiments that annexing a tube to a submerged square orifice will greatly increase its flow under a given head, until the length of tube is equal to about 1½ times the side of the square. A longer tube will not decrease the flow, unless the friction is large, but it will not materially increase it.

Another interesting fact brought out is that for free discharge into the air the coefficient does not vary, but remains at about 0.610, whatever the tube length. This value is about ⅔% greater than the submerged sharp-edge coefficient and corresponds to the submerged coefficient for $L/D = 0.05$. From this it follows that, given a square orifice with a tube attached and a fixed head of water upstream, a greater quantity may be made to flow through the orifice by submerging the downstream side than will flow if the orifice discharges into the air. This fact was verified by experimentation.

These experiments formed part of the work on an undergraduate thesis at Cornell University. The writers desire to acknowledge the aid of Prof. E. W. Schoder in suggestions as to the scope and conduct of the work.

Resurfacing Macadam Roads with Small Brick Cubes

Some years ago J. Y. McClintock, County Engineer of Monroe County, N. Y., devised a new type of road in which 2-in. cubes of concrete laid on a sand or stone bed formed the wearing surface. The first experimental road was described in *Engineering News*, Mar. 3, 1910.

Some of these stretches of road have been in service for five or six years, but they have not proved entirely successful, mainly, it is thought, because of the lack of strength or toughness in the concrete itself. The individual blocks have broken or become edge worn, so that it has been necessary to replace them or to cover with an asphalt or tar coating.

About the same time, however, experiments were made with similar small cubes made of clay, and these have worn much more satisfactorily, so much so in fact that Mr. McClintock is favorably inclined to use them extensively in resurfacing worn macadam roads. This season he has covered an experimental stretch with apparent success, although the test of time has not yet been applied.

The blocks used are 2¼-in. cubes of vitrified clay, made by the Corry Brick and Tile Co., of Corry, Penn., and supplied at Rochester for $2.50 per 1,000. Each block weighs about 1 lb. In resurfacing the road the old worn top is brought up to a smooth crown with sand and then rolled. On this surface the cubes are placed by hand, covered with a light coating of sand and the whole rolled to make the finished road. So far no joint binder has been used.

In placing the cubes they are first laid out on a pallet—work that can be done by a boy. The filled pallet is then put down on the rolled surface and slid from under the cubes, leaving them in place except for simple tapping with a hammer. For stretches already put down, the resurfacing costs about $8,000 a mile for a 12-ft. width of road.

The advantages claimed for the method are its cheapness, the ease with which local labor can be used, which is an important consideration in county work, and the readiness with which repairs can be made. If blocks wear down or break, they can be replaced by picking out and setting others in place. It is claimed that the road has a desirable resiliency also. It resembles in surface an ordinary brick road.

In Monroe County, experiments were also made with local clay, which cannot be vitrified, and some sections of road with 2-in. cubes of this material were tried. It was found, however, that they were not tough enough to stand up under traffic. The 2¼-in. vitrified cubes are being used for the pavement of the new county bridge across the Genesee River at Charlotte.

Conservation of Stream Flow, the Pennsylvania State Water-Supply Commission says in its annual report, is needed in some sections of Pennsylvania to supply the public requirements for water for domestic and industrial uses, as well as to safeguard against floods. Already in some cases, as on the Beaver River, industrial development is checked because of limited water-supply. The commission advises that, judging by experience of the Miami Conservancy District in Ohio, complete investigation of river regulation would cost about $15 per sq.mi. of drainage area. At this rate, the cost of a complete hydraulic survey of Pennsylvania, developing the possibilities for flood control, water-supply and water power would cost about $800,000. If the survey is carried on without interruption, it would be completed in five years. For lack of such comprehensive hydrographic knowledge, unfortunate investments are frequently made.

Drawbridge-Type Locomotive Turntable 100 Ft. Long

SYNOPSIS—This table is fixed rigidly by end-rail supports when in position and does not tilt as engines run on and off the table. It is designed to turn very long Mallet locomotives.

In the design of new 100-ft. turntables for the Atchison, Topeka & Santa Fe Ry. special study was given to the problem of eliminating the pounding action that ordinarily occurs when engines are run on and off the table. The first of these tables is shown in Fig. 1, installed at Albuquerque, N. M.

Locomotive turntables when unloaded normally swing with the ends free and unsupported, and a source of trouble and expense with long tables is the pounding at the ends as the engine wheels cross the gap and the table tilts under the load. As one end of the table is apt to be higher than the fixed or radial tracks (especially in old tables), the longitudinal blows from engines running on at this end are destructive to the center and its anchorage. On the Atchison System the experience has been that, with turntables of ordinary construction in pits 75 to 90 ft. in diameter, the annual cost for repairs to end wheels and center is from $400 to $500. With longer tables and the very heavy engines carried, the drop and pound at the ends would be much more serious.

The new 100-ft. turntable is designed like a swing-bridge, with the rail ends projecting over the circle wall and having a bearing on the wall when the table is ready to receive an engine. This construction is shown in Fig. 2. In this way there is no open gap between the fixed rail and the table rail, and no tilting of the table, the rails being held rigidly at the same level. The end-rail supports also render an end lock unnecessary, as they can be applied only when the table is in proper relation to the radial track, and when thus applied the table cannot be shifted from its position.

The table is operated by a tractor running on the pit rail and driven by a 20-hp. electric motor. The tractor is hitched to one end of the table, which swings on a center bearing; but at the motor end there is a counterweight on the end floor-beam so that when the table is empty the carrying wheels at this end are always down on the pit rail and the table rails are always level with the fixed rails. In other words, the empty table is always tilted, with its motor end down, as in Fig. 2.

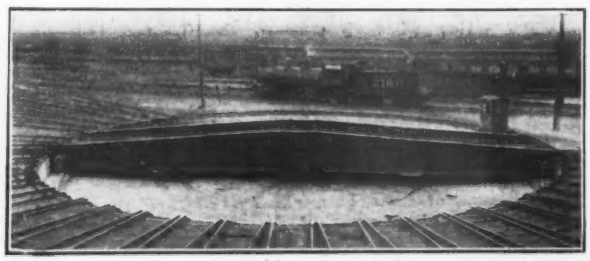


FIG. 1. DRAWBRIDGE-TYPE TURNTABLE WITH END-RAIL SUPPORTS

The rules provide that the table must always be turned so that locomotives run upon it at the motor (low) end. They can be run off at either end, the weight of the engine bringing the high end down to the level of the fixed radial tracks, so that the rail locks at this end can be operated.

On the circular wall of the pit the ends of the rails of the radial tracks are supported by heavy cast-steel blocks bolted to timber sills on the masonry. These

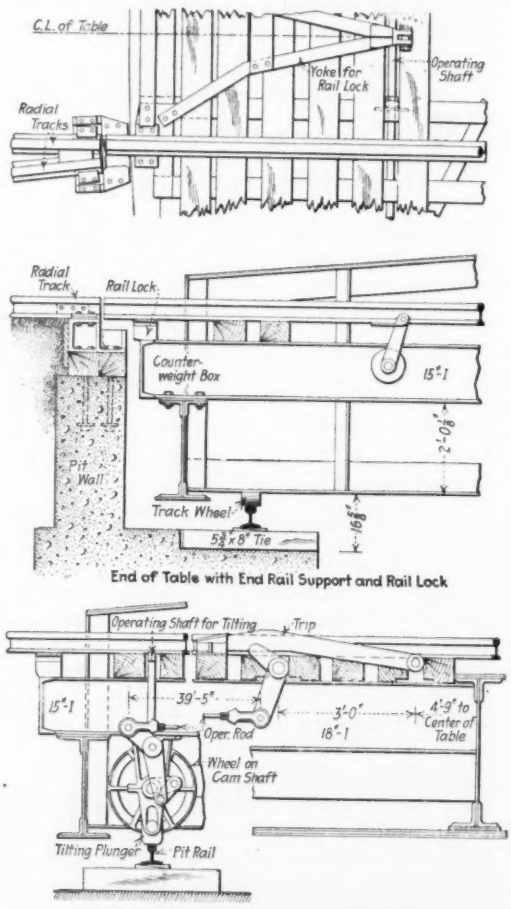


FIG. 2. END OF 100-FT. DRAWBRIDGE-TYPE TURNTABLE

blocks extend beyond the rail ends, and the table rails project over the blocks. Shoes or wedges are fitted beneath the ends of the table rails, Fig. 3, and when the table is in position and centered these shoes are driven forward (sliding on the base of the rails) so as to bear upon the inclined seats of the blocks upon the circle wall. This makes a rigid connection. If the engine is to run off at the opposite end, it is moved into such position as to lower that end, and the locks are then operated as above.

The centering or end-lock device consists of a V-shaped yoke placed between the rails (Fig. 4). The rail shoes are attached to its ends and suspended from the track rails. The apex of the yoke is connected to an

arm on a transverse shaft operated by a hand lever outside the girder, so that by turning the shaft the yoke (with the end shoes or wedges under the rails) is shifted to and fro.

In the first table of this type, mechanism was fitted to allow engines to run on at either end. For this purpose a tilting device (shown in Fig. 2) was placed at the motor end. A camshaft operated a vertical plunger, which when lowered would take a bearing on the circle rail and raise this end of the table so as to lower the opposite end correspondingly and enable the rail shoes to be driven. In order to prevent breakage of the tilting device due to the weight of the engine, a tripper was used to release the load. The tripper consisted of a track lever operated by the first wheel of the locomotive entering the table and crossing the center, thus shifting the camshaft so as to pull up the plunger and leave the motor end of the table unsupported.

The tilting and tripping devices were applied to the first table only and were used for only a short time. While the operation was effective and satisfactory, it was found that the additional cost and complication could be saved by requiring the table to be turned so that its motor end always receives the load. This arrangement does not cause any appreciable delay in the service.

The table illustrated is installed at Albuquerque, N. M., in a pit 100 ft. in diameter. It is of the through type, with steel plate girders, floor-beams and stringers. The table itself weighs a little over 90 tons. With the cast-steel blocks to support the ends of the table rails and the fixed rails of 46 radial tracks, the weight complete of the table at Albuquerque is about 109 tons. The dead-load is 1,800 lb. per ft., (1,300 lb. for steel and 500 lb. for track). Construction is shown in Fig. 3. The main girders are 97 ft. 5 in. long over all, with a depth of 7 ft. 6¼ in. at the center and 4 ft. 6¼ in. at the ends. They are spaced 15 ft. c. to c. They have ½-in. webs, with flange angles 8x8x¾ in., and top and bottom cover plates. There are stiffeners on both sides, and inside gusset plate connections with the floor-beams. Framed between the girders and resting on their bottom chords are ten transverse plate girders. The two at the middle are 40-in. loading girders 6 ft. 8 in. apart. Six of the others are 42-in. floor-beams. The two end floor-beams are only 25 in. deep, so that they can be placed under the stringers. There are four lines of stringers, these being 18-in. I-beams, except that in the end panels 15-in. I-beams are used. Diagonal bottom lateral bracing is fitted in each panel.

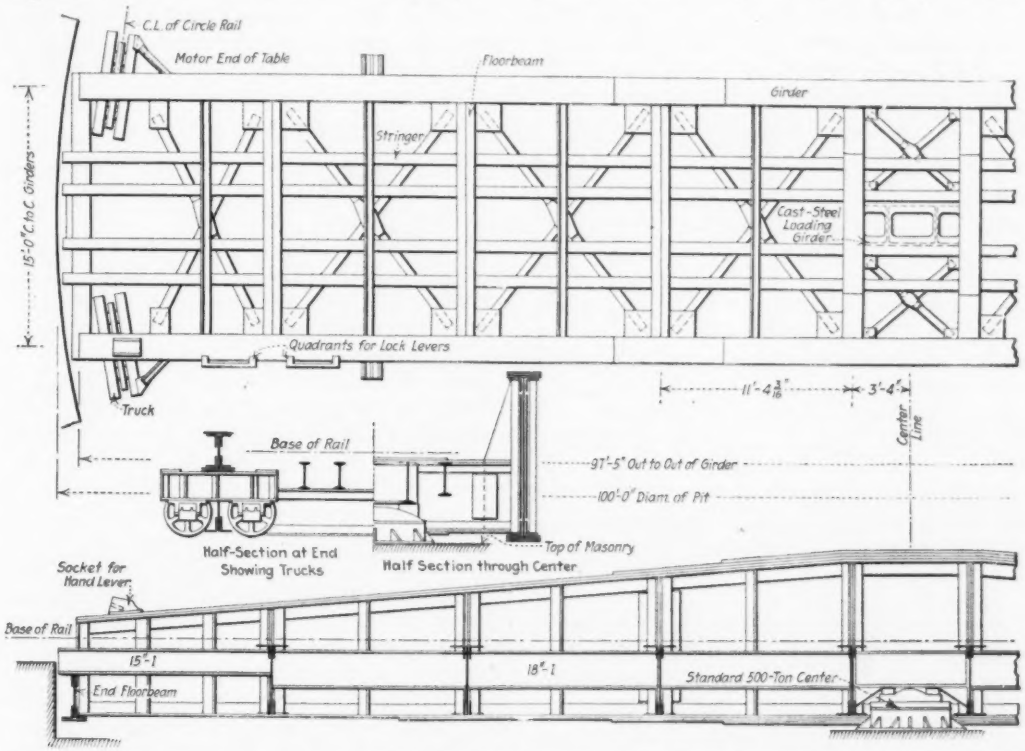


FIG. 3. TURNTABLE 100 FT. LONG, WITH END-RAIL SUPPORTS; ATCHISON, TOPEKA & SANTA FE RY.

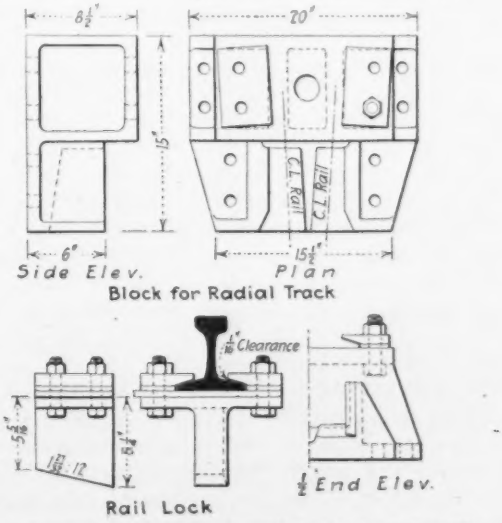


FIG. 4. DETAILS OF END BLOCKS AND RAIL LOCKS

The depth of floor was insufficient for loading girders of plate-girder construction (between the two floor-beams at the center), and in their place there is a cast-steel loading frame fitted between the floor-beams. This frame is about 6½x4 ft., and 3 ft. 1 in. deep, secured by 1-in. rivets.

The table has the railway company's standard center designed for a swinging load of 500 tons. The load is carried by 20 rollers of hardened steel, riding on nickel-steel tracks in the fixed base and revolving head. At each corner of the table is a truck having a frame of a pair of 15-in. I-beams. Upon the I-beams is a seat carrying the end of the girder, and beneath them are the bearings for a pair of 27-in. wheels having their 5-in. treads coned $\frac{3}{32}$ in. in 12 in.

The deck consists of 6x8-in. ties laid across the stringers, with their ends resting on shelf angles on the girder webs. They are secured to these angles and the outside stringers by hook bolts. The ties are spaced 12 to 14 in. c. to c. and have two rows of filler blocks between them to prevent any creeping. Side strips along the ends of the ties, fitted between the stiffeners, hold the ties in place. The track is laid with 90-lb. rails, outside of which are guard timbers 6x8 in., boxed out for the ties and bolted to them. Timbers 6x6 in. protect the end-rail operating yoke, and over the center is a plank cover with ring bolts for handling. On the floor-beams are blocks 2x12 in., 30 in. long, one under each rail.

The radial tracks (46 at Albuquerque) have full-length 90-lb. rails abutting on the pit wall. Their ends are sawed square to the table track, and the clearance between the fixed and table rails must not exceed ¾ in. Cast-steel angle blocks are bolted between the ends of the radial rails.

The circle track in the pit has a radius of 47 ft. 2½ in. to center of rail. It has a 90-lb. rail, carried by creosoted ties 5¾x8 in., 3 ft. long, placed radially. These are spaced 12 in. c. to c. at the main approach tracks and 18 in. c. to c. elsewhere. On each tie the rail is seated on a pair of wedge tie-plates, which provide for adjustment of level.

The pit is 5 to 6½ ft. deep (beneath rail level) and is paved with 5 in. of concrete. The circle wall is of concrete 18 in. thick, with a footing 6 ft. wide to carry the circle track. Below this is a concrete base. On top of the wall are two circular lines of timbers, secured by anchor bolts and carrying the rail blocks. A concrete pedestal supports the center, and a 6-in. pipe extends under the pit and up through this pedestal to carry the wiring for power. In the floor of the pit are four concrete pedestals or jack blocks. With the table swung over these, jacks can be placed under the girders to raise the table for inspection.

The table at Albuquerque is designed specially for handling Mallet engines of the 2-6-6-0 class, weighing 293 tons and having a total wheelbase of about 90 ft. for engine and tender. In these engines the distance from the center of the forward wheel to the center of gravity is 46 ft., or 39 ft. with tender empty, so that the engine can be approximately centered and balanced on the table. A four-wheel switching engine used in the yard has about 63,000 lb. on one axle and 45,000 lb. on the other. This engine and a passenger engine of the 4-6-2 class are commonly turned together on the table. Although this load cannot be centered, the lack of balance has not been found to interfere with the ready operation of the table. It can be turned through a full circle in 1½ min. This table was built by the American Bridge Co.

The new type of turntable described above, with its end-rail supports, tilting device and other special features, was designed by A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Sante Fe Railway System.

More Details of Sioux City Concrete Paving Practice

By T. H. Johnson*

In answer to many queries which have arisen in regard to the why and wherefore of our methods of constructing concrete pavements in Sioux City, Iowa, described in *Engineering News*, July 27, 1916, the following has been prepared.

Why not use a strike-board? I would not consider abandoning our method of finishing with heavy floats in order to use a strike-board, and I think the heavy floating would develop the unequal densities of the strike-board surface, just as rolling develops the soft spots in the foundation; and we would have to depend on the floating for the final surface anyway.

There are most excellent reasons why we do not use a templet or strike-board. Our streets are nearly all hill-side streets, with the grade on one side frequently from 2 to 4 ft. higher than on the other side. Three-quarters of all the streets so far paved had previously been provided with combined curb and gutter. The form of the gutters and the widely varying heights on opposite sides of the street have made it impossible to use any regularity in crowning the pavement. Our crowns in extreme cases vary in a single block from nothing to 18 in. Our workmen soon learn to form a good street surface without the use of a strike-board, and we have continued to get along without it even where conditions would have permitted its use.

However, I think that there are legitimate objections to the use of a strike-board. Where a mix is used as dry as is being insisted on by most theorists, the use of a strike-board would tend to pull the coarse aggregate away from its mortar bond on one side, and so weaken the concrete. It would certainly increase the density in front of and lessen it behind the particles of coarse aggregate, destroying the uniformity of the structure.

In using the strike-board there is not a uniformly distributed quantity of concrete carried along in front. Parts of the surface the strike-board scarcely touches, passing over without disturbing the concrete. On other parts the quantity of concrete in front will be considerable, and the strike-board will show a tendency to ride or will act in part as a tamper. Again the result is unequal density. The workman in removing the surplus concrete from in front of the strike-board still further aggravates this condition.

The usual directions for using a strike-board when approaching a joint are to move it forward and work it away from the joint. Working the strike-board away from the joint on both sides is especially harmful. It is wrong in principle and should never be practiced.

*City Engineer, Sioux City, Iowa.

In general any method of laying concrete pavement that omits a possible means of uniformly increasing its density, is wrong. How much more then is a method that tends to decrease the density?

The following analysis of Sioux City paving practice has been prepared to show in as brief a form as possible the why and the wherefore of each detail of practice:

AN ANALYSIS OF SIOUX CITY'S PAVING PRACTICE, SHOWING ADVANTAGES THAT ACCRUE OVER AND ABOVE THOSE OF STANDARD PRACTICE

Floating with heavy floats before applying dry mixture	Aligns flattest surfaces of coarse aggregate with finished surface of pavement		
	Compresses concrete, forcing water out through the surface	Increases density and strength of concrete	
		Brings cement toward surface	Increases strength and resistance to abrasion
			Makes concrete easier to place
		Permits a wetter mix	Makes structure more uniform
			Makes concrete denser and stronger
			Saves tamping
Application of rich dry mixture	Extracts surplus water	Avoids use of bridge in finishing	
		Hastens time of finishing	
		Makes concrete denser, therefore stronger	
		Increases richness and strength toward top where it is needed	
	Neutralizes laitance		
	Reinforces surface, making it strong and wear-resisting		
	Gives additional mortar to finish surface without disturbing coarse aggregate		
	Renders possible a very wet mix	Greater ease in placing	
		Finishing without a bridge	
		Greater uniformity in structure of slab	
		Avoids injurious absorption by the base and evaporation from the surface	
Floating after placing dry mix and until setting begins	Increases density	Makes concrete stronger	
		Makes concrete less absorptive	More sanitary
			Lessens expansion and contraction, reducing tendency to crack
	Gives rough surface without brooming		
	Retards setting of surface concrete	Preventing shrinkage cracks	
		Increasing strength	
Finishing joint with "edger"	Gives thick, round corner not easily broken		
	Gives dense, hard troweled finish which is strong and wear-resisting		
	Avoids the use of protection plates		

I would like to add a few observations regarding the general outcry against a wet mix for concrete pavements. The argument against a wet mix is based on the results of laboratory tests, showing that a flowing consistency is not so good as one that requires light tamping. These tests also show that a slightly drier consistency is not so good as one requiring just light tamping.

If these tests prove anything, they prove that a thinner consistency than the ideal laboratory one should be used in a pavement, because in a pavement the concrete is spread in a comparatively thin layer, one surface of which is in contact with fresh earth, in an ideal condition to absorb moisture unless wetter than the concrete—which it never is—while the other surface is exposed to the drying effect of the atmosphere.

Street Dirt and Cleaning Not Measurably Unhealthful

Another Banquo's ghost that has been wont to frequent the banquets of medical health officers has been laid low after two years of careful investigation by the Committee on Street Cleaning of the Sanitary Section of the American Public Health Association. The results of this investigation were presented at the recent Cincinnati convention of the Association by Samuel Whinery, Chairman of the Committee, in the form of a somewhat lengthy report signed also by the other committee members; namely, George H. Norton, Buffalo, John T. Fetherston, New York City, C. M. Talbert, St. Louis, and Richard T. Fox, Chicago. The conclusions of the report have all the more force because they are based not only on a study of matter previously in print but also on the responses to a questionnaire. Such of these responses as were available for use were, it is true, limited to a baker's dozen, but they have much weight because they come from such men as John T. Fetherston, Commissioner of Street Cleaning, New York; Dr. Haven Emerson, Commissioner of Health, New York City; Dr. Charles V. Chapin, Superintendent of Health, Providence, R. I., and Frederick L. Hoffman, Statistician, Prudential Insurance Co., Newark, N. J.

The conclusions of the committee are summarized in the report as follows:

In view of all the facts disclosed, and notwithstanding the testimony and opinion that street dirt is not, on the whole, a serious menace to the public health, there is abundant reason for believing that street dust is a deleterious element in urban life, and that it is the principal source of danger to the public health from dirty streets and street cleaning operations.

If this be so, great attention should be given to preventing its formation, and to its prompt and effectual removal from city streets.

Summarizing the results of our investigation the following conclusions seem warranted:

1. That street cleaning and work connected therewith, as an occupation, is but little if any more unhealthful than the average of other laboring occupations.

2. If street cleaners, who are constantly engaged upon the streets, and therefore intensively subjected to the effects of street dirt in all its forms, are not injuriously affected thereby, no great danger to the public health from street dirt and street cleaning operations is to be apprehended.

3. That such danger therefrom as may exist is almost wholly attributable to street dust.

4. The dumps and land-fills composed of street waste (unmixed with garbage) are not notably detrimental to the public health.

5. While disease germs doubtless exist in street dirt and dust there is, at present, no positive evidence available that such germs are responsible for specific diseases, though the possibility and even probability of contagion thereby should be assumed.

It should be noted that we are, in this report, dealing with the sanitary aspects, alone, of street cleaning. There are abundant reasons for keeping city streets clean regardless of the public health.

In conclusion the committee again calls attention to the paucity of actual statistics and accurate scientific investigation in this field. The possible importance of the subject as a factor in the public health entitles it to more careful study.

The number of employees in the street cleaning departments of our cities is sufficient to warrant their segregation into a separate class of industrial workers, and it is urgently recommended that street cleaning departments, public-health departments and the hospitals shall provide and maintain an adequate system of observations and records that shall enable us to arrive at reliable, definite conclusions as to the true sanitary aspects of street dirt and street cleaning.

It is well worth noting that figures for the six years, 1909 to 1914, for an average of 5,504 employees in the Street Cleaning Department of New York City, show a death rate of 14.8 per thousand compared with a death rate of 15 for all males between the ages of 20-69 in the whole of New York City.

The Life of Railway Rolling Stock on some of the older railways of New England appears to be pretty long. A report has just been made to the Public Service Commission of Massachusetts on the passenger service of the New York, New Haven & Hartford R.R. The report, presented by George W. Bishop, Chief of the Inspection Department of the Commission, shows that the company has about 252 locomotives engaged in local passenger-train service in Massachusetts which are from 13 to 36 years old. Of these, 168 are too small to give good service under the conditions imposed upon them, and engine failures with them are frequent. The company operates about a thousand wooden cars in local passenger-train service in Massachusetts. About half of these are in good condition, and half of the remaining number need to be repaired to give good service. The remaining 250 have been in service from 29 to 40 years and are in generally poor condition. Recently the company retired 25 of these cars, and it has assured the Inspection Department that 169 more will soon be taken out of passenger-train service.

Traffic-Census Methods and Some Results; St. Louis

By William Holden*

SYNOPSIS—Methods of taking an extended traffic census, tabulating and platting data and some of the changes in traffic conditions that were shown; also some statistics of standing vehicles and the regulation of traffic by ordinance.

The City of St. Louis has recently completed an elaborate traffic census with the following objects in view: (1) Regulation of traffic by ordinance; (2) provision of suitable pavement; (3) making more direct connections and eliminating obstructing jogs in the street system; (4) widening existing roadways and opening up new thoroughfares where necessary.

The taking of an annual traffic census was started by the Street Department in October, 1913. In that year counts were made on the most important streets in the downtown section. Observers were stationed at intersections, and counts were made of vehicles only, separating them into four classes—one-horse, two-horse, passenger automobile and motor trucks. The department was chiefly interested in determining the volume of traffic of various classes, and no attempt was made to determine tonnage.

Each year the territory covered by the traffic census was extended until in 1915 it included not only the entire downtown district, but covered the main traveled arteries leading to the residential districts and the principal

FIG. 1. FIELD SHEET FOR TABULATING TRAFFIC CENSUS (HALF SIZE)

cross-streets. The census of 1914 and of 1915 included street cars. In 1915, observations were made at 173 points for the regular day census and at 14 points for the night-traffic census between the hours of 6 and 10 p.m.

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In 1913, 1914 and 1915, counts of the number of standing vehicles in the downtown districts were also made for the purpose of determining the amount of available roadway and also the curb space occupied, which would serve as a basis for proper regulation of parked vehicles.

In 1913 and 1914 the observers were stationed at the street intersections, two men being used for each. The observers were located on corners diagonally opposite each other. Each man counted traffic moving in the direction

FORM 1. TABULATED STATEMENT OF TRAFFIC.
LOCATION- Chestnut St. Bet. 4th St. & Broadway
DIRECTION- East and West Bound
DATE Oct. 19th 1915 INSPECTOR H. P. Maher WEATHER Clear

HOUR BETWEEN	East BOUND One Horse	East BOUND Two Horse	East BOUND Passenger Auto	East BOUND Auto Truck	East BOUND Street Car	West BOUND One Horse	West BOUND Two Horse	West BOUND Passenger Auto	West BOUND Auto Truck	West BOUND Street Car	TOTALS One Horse	TOTALS Two Horse	TOTALS Passenger Auto	TOTALS Auto Truck	TOTALS Street Car	ALL VEHICLES	VEHICLES & ST. CARS
7 & 8 A.M.																	
8 & 9 "	24	22	122	20		18	12	26	14	17	42	34	148	34	17	258	275
9 & 10 "	15	11	92	12		15	21	36	11	10	30	32	98	23	10	193	193
10 & 11 "	34	16	61	15		31	17	31	10	10	65	33	92	25	10	215	225
11 & 12 "	24	10	68	15		30	9	44	15	11	54	19	112	30	11	215	226
12 & 1 P.M.																	
1 & 2 "	15	8	54	20		14	11	47	16	10	29	19	101	36	10	185	195
2 & 3 "	21	15	52	12		10	13	70	11	10	31	28	122	23	10	204	214
3 & 4 "	31	10	46	14		20	12	47	17	11	51	22	93	31	11	197	208
4 & 5 "	29	6	66	20		19	10	90	27	14	48	16	156	47	14	267	281
5 & 6 "																	
TOTALS	193	98	561	128		157	105	391	121	93	350	203	952	249	93	1724	1817
FORWARDED	219	137	577	135		212	118	530	128	107							
GRAND TOTALS	412	235	1138	263		369	223	921	249	200							
AV. PER HR.	24	13	66	15		21	13	54	14	11	45	26	120	29	11	339	350

FIG. 2. FORM 1, FOR TABULATING HOURLY TRAFFIC

which passed on his side of the street. On a few of the extra-busy intersections it was necessary to use four men, each man taking traffic in one direction only.

In 1915 another method was adopted, which is now generally used, of stationing the observers in the middle of the block. Each man counts only the traffic on his street, which is moving straight past him. This eliminates the possibility of confusion due to vehicles turning the corner and being counted twice or not at all. By this method the traffic in any block on any street is counted direct. Likewise by taking the proper direction from the records of the observers in each of the four adjoining blocks, the traffic coming to any intersection can be arrived at. On two or three streets where traffic was exceptionally heavy it was necessary to place two men to the block, each man counting traffic bound in one direction only. In 1913 and 1914, counts were made for two days at each point.

In the first two years the count extended from 8 a.m. to 5 p.m., omitting the noon hour. In 1915 by a shift in the two days' count, the observations covered from 8 a.m. to 6 p.m., not including the noon hour. The 1915 census was taken during the last two weeks of October, not including Sundays. The weather was clear and the atmosphere moderate for the entire period.

RECAPITULATION

TABULATED STATEMENT OF TRAFFIC

AT VARIOUS CORNERS WITHIN THE DISTRICT BOUNDED BY WASHINGTON AVE., CHESTNUT STR., FOURTH ST. & TWELFTH ST.

ALSO OTHER CORNERS AS NOTED

OCTOBER 1915.

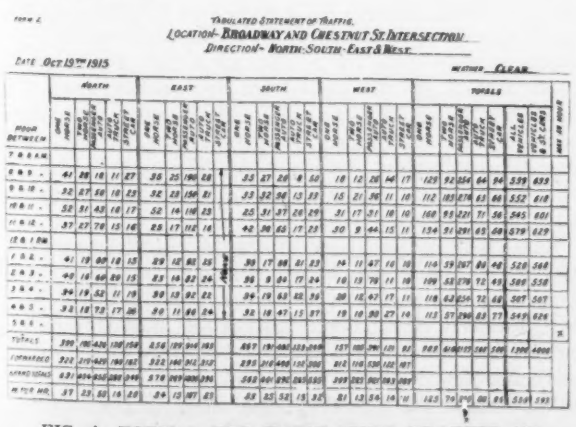
LOCATION	AVERAGE PER HOUR NORTH.					AVERAGE PER HOUR EAST.					AVERAGE PER HOUR SOUTH.					AVERAGE PER HOUR WEST.					AVERAGE TOTALS PER HOUR.					AVERAGE TOTALS PER HOUR 1914.					PER CENT		MAXIMUM PER HOUR 1915					1914						
	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCK	STREET CARS	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	INCREASE	DECREASE	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS. AUTO	AUTO TRUCKS	STREET CARS	VEHICLES	VEHICLES & STREET CARS	BETWEEN HOUR	MAXIMUM HOUR
4TH & WASHINGTON.	38	38	71	16	173 / 12	18	19	91	15	197 / 54	17	18	9	9	69 / 16	14	17	41	13	136 / 51	87	92	210	52 / 23	573 / 123	120	125	112	68 / 42	505 / 103	10		117	113	189	73 / 60	671 / 198	403	657	11	8 - 9
4TH & ST. CHARLES.	42	30	79	17	181 / 13	17	25	13	5	60 / 0	30	32	92	14	130 / 12	18	20	17	5	60	107	107	151	41	25	131	115	86	27	359 / 73	13		137	112	153	53 / 31	726 / 23	429	450	8	10 - 11
4TH & LOCUST.	37	28	61	17	227 / 64	10	11	59	6	69 / 0	13	27	44	15	133 / 13	8	11	29	7	45 / 14	88	77	193	35	344 / 171	112	95	124	30	461 / 186	8		98	85	140	39 / 42	623 / 288	458	592	10	8 - 9
4TH & OLIVE.	34	28	63	16	173 / 34	13	5	27	4	103 / 54	32	28	49	12	138 / 12	11	8	26	5	58 / 0	91	69	164	37	441 / 100	96	74	111	15	355 / 55	22		95	67	175	32 / 42	455 / 76	372	464	7	2 - 3
4TH & PINE	30	28	72	17	182 / 37	14	8	25	7	77 / 23	33	26	55	14	148 / 22	14	10	26	8	58 / 28	90	73	178	46	387 / 165	139	107	137	33	416 / 137	7		107	89	221	49 / 49	533 / 87	468	580	9	11 - 12
4TH CHESTNUT.	22	21	32	11	134 / 46	24	13	66	15	118 / 0	31	28	59	16	144 / 12	21	13	54	14	113 / 11	98	75	211	56	440 / 169	115	92	112	26	345 / 63	27		85	58	329	53 / 41	625 / 120	396	455	10	5 - 6
BOWY & WASHINGTON	39	22	76	14	204 / 60	21	19	102	17	212 / 53	29	24	95	15	147 / 34	16	11	102	14	203 / 52	102	82	323	60	567 / 169	125	76	176	45	446 / 196	21		131	100	229	57 / 34	660 / 327	401	740	14	8 - 9
" & ST CHARLES	32	20	84	15	216 / 59	20	23	12	5	62 / 0	29	25	45	13	112 / 33	18	20	17	5	60	99	90	156	33	378 / 90	150	116	119	40	425 / 56	8		132	166	166	57 / 97	529 / 78	521	502	8	10 - 11
" & LOCUST	27	22	87	16	192 / 60	19	7	112	7	136 / 0	29	20	50	15	147 / 26	8	11	35	7	139 / 74	74	60	204	35	433 / 167	101	69	180	38	388 / 162	14		109	78	313	55 / 57	700 / 145	436	620	11	10 - 11
" & OLIVE	27	22	68	14	185 / 64	12	7	31	5	123 / 48	36	28	60	15	187 / 61	11	8	26	5	88	80	57	205	39	381 / 103	90	69	131	30	320 / 52	19		100	76	201	49 / 29	627 / 265	396	595	10	9 - 10
" & PINE	36	22	61	15	193 / 33	16	9	34	5	123 / 59	27	21	53	15	176 / 23	14	10	28	8	84 / 28	93	62	174	43	372 / 185	125	88	105	41	359 / 176	9		123	73	178	52 / 46	532 / 228	396	671	8	9 - 10
" & CHESTNUT	37	23	50	16	166 / 20	34	15	107	23	179 / 0	33	23	33	15	155 / 0	11	11	44	8	112 / 0	115	72	227	43	457 / 0	120	80	195	43	438 / 0	9		123	73	178	52 / 46	532 / 228	396	671	8	9 - 10
6TH & WASHINGTON	37	23	50	16	174 / 20	34	15	107	23	179 / 0	33	23	33	15	155 / 0	11	11	44	8	112 / 0	115	72	227	43	457 / 0	120	80	195	43	438 / 0	9		123	73	178	52 / 46	532 / 228	396	671	8	9 - 10

FIG. 3. SUMMARY SHEET OF ST. LOUIS, MO., TRAFFIC CENSUS

The men used in making the 1915 count were for the most part average inspectors from the Street and Sewer Divisions, together with a few additional inspectors borrowed from other departments. About one-half of these men had had some experience in previous counts. An assistant supervised the count, collected daily reports, made assignments of new locations and later handled the clerical force in tabulating and compiling the data under the general direction of the engineer-in-charge.

The forms used were made as simple as possible. The field sheet, Fig. 1, shows in headings the location of the observer, direction of traffic observed, date, weather, inspector's name, and hour recorded on the particular sheet. Generally one sheet was used for each hour. A vehicle drawn by two or more horses, as Fig. 1 shows, was counted as a two-horse vehicle. It was found that the best observers were able to take care of all traffic bound in one direction even on the busiest street, which amounted to a maximum of about 870 vehicles per hour.

At the end of each day the men were required to total the columns for each hour on field sheets and enter these on Form 1 (Fig. 2). The field sheets were attached to Form 1 and sent to the office the following morning. As soon as the work of the inspector in totaling and transferring the data from field sheet to Form 1 was checked, the field sheets were dispensed with. From Form 1 the traffic on each street in both directions was reduced to an average per hour.


FORM 2.

TABULATED STATEMENT OF TRAFFIC.

LOCATION- BROADWAY AND CHESTNUT ST. INTERSECTION.

DIRECTION- NORTH-SOUTH-EAST & WEST.

DATE OCT 19TH 1915 WEATHER CLEAR

HOUR BETWEEN	NORTH					EAST					SOUTH					WEST					TOTALS						
	ONE HORSE	TWO HORSE	PASSENGER AUTO	AUTO TRUCK	STREET CARS	ONE HORSE	TWO HORSE	PASSENGER AUTO	AUTO TRUCK	STREET CARS	ONE HORSE	TWO HORSE	PASSENGER AUTO	AUTO TRUCK	STREET CARS	ONE HORSE	TWO HORSE	PASSENGER AUTO	AUTO TRUCK	STREET CARS	ONE HORSE	TWO HORSE	PASSENGER AUTO	AUTO TRUCK	STREET CARS	ALL VEHICLES	VEHICLES & STREET CARS	HOUR
7 TO 8 A.M.																											
8 TO 9 "	41	28	18	11	27	35	25	190	28		33	27	26	8	52	18	12	28	44	17	129	92	256	64	96	339	635	
9 TO 10 "	32	27	50	18	23	32	23	156	21		33	32	56	13	33	15	21	36	11	10	112	103	278	63	66	552	618	
10 TO 11 "	32	21	43	18	17	32	14	110	23		25	31	37	20	29	21	17	31	18	10	100	83	221	71	56	545	601	
11 TO 12 "	37	27	70	13	16	25	17	112	16		42	36	65	17	23	30	9	44	15	11	134	91	291	65	68	679	629	
12 TO 1 P.M.																											
1 TO 2 "	41	19	80	18	15	29	12	82	25		39	17	88	21	23	14	11	47	16	10	116	59	297	80	48	520	568	
2 TO 3 "	40	16	66	20	15	23	16	82	24		36	9	84	17	24	18	13	78	11	10	109	53	278	72	45	508	558	
3 TO 4 "	34	19	52	11	19	30	13	92	22		34	19	62	22	35	20	15	67	17	11	118	63	256	72	68	507	507	
4 TO 5 "	32	18	72	17	20	30	11	80	24		32	18	47	15	27	19	10	50	27	10	113	57	296	83	77	549	626	
5 TO 6 "																											
TOTALS	299	195	426	126	154	256	171	1020	208		351	210	508	133	266	157	108	396	170	87	963	624	2125	570	523	5805	6004	
INCREASED	322	219	469	190	182	322	190	912	232		385	216	498	130	300	212	116	536	182	97								
DECREASED	23	24	43	64	28	66	19	108	24		34	6	10	3	34	55	8	140	12	10								
GRAND TOTALS	621	414	895	316	336	578	361	1932	440		736	426	1006	263	566	369	224	932	352	184								
HOUR MAX.	37	23	50	18	20	34	15	107	23		39	23	33	15	35	21	13	56	16	11	123	79	296	80	68	559	595	

FIG. 4. FORM 2, FOR TABULATING TRAFFIC AT INTERSECTIONS

From recorded directions by the observers in the four adjoining blocks only the traffic coming toward the intersection is entered on Form 2 (Fig. 4). This gives at the bottom the average per hour in each direction and the total of all four directions. In the column of hourly totals at the right are given combined totals for each hour. By taking the average for the two days for each hourly total, is determined which hour in the average day shows the maximum traffic. The total of vehicles and street cars was considered in arriving at the maximum hour.

From Form 2 of the traffic at various intersections is made up a recapitulation of tabulated traffic, Fig. 3. The average number of units per hour in each direction is totaled, and the total is placed in the street-car column above the number of street cars per hour. Thus at Fourth and Washington Ave. the average per hour of northbound vehicles plus street cars was 175, the 12 below being the average number of street cars per hour. In the average totals per hour and the maximum hour are the whole number of vehicles, placing this sum over the number representing motor trucks and the number of vehicles plus street cars over the number representing street cars.

Traffic Charts

In order to present the traffic data a little more clearly, traffic charts were plotted as follows: (1) Average traffic for each street in the downtown district; (2) maximum traffic for intersections in the downtown district; and (3) traffic of the congested district.

The Average Traffic charts show the average number of vehicles per hour (sum of both directions) and vehicles plus street cars in each block observed on the street under consideration. On these charts, as on Maximum Traffic charts, black lines represent total vehicles and the shaded lines represent total vehicles and street cars combined. On the Average Traffic charts (Fig. 5) the horizontal base represents the street, divided into blocks by the vertical lines representing the intersecting streets. The vertical dimension is ruled off into 1-in. spaces which represent 40, 60 or 100 vehicles (or vehicles and street cars), depending on the scale used, which varied in accordance with the amount of traffic carried. The average number of vehicles per hour (total of all classes) for each block was platted in the middle of the section representing that block on the chart. These points were connected by lines. The combined number of vehicles and street cars

was platted for each block, and the points were connected with a shaded line. From the Average Traffic charts the fluctuation of traffic per hour in different blocks can readily be seen. On account of their effect on the volume of traffic there are also shown width of roadway, kind of pavement and number of car tracks on the Average Traffic chart of each street.

The Maximum Traffic chart for each street shows the number of vehicles and vehicles plus street cars crossing each intersection on the street during the maximum hour from all four directions. The horizontal base line represents the street under consideration, and the vertical lines represent the cross-streets. The total number of vehicles during the maximum hour for each intersection is platted on the proper vertical line representing the cross-street. The numbers to use in the maximum charts are most conveniently taken from the totals shown during the maximum hour in the recapitulation of tabulated traffic (Fig. 3). The relative volumes of traffic at the different intersections, as well as that of the 1914 census, are readily compared from these charts.

A Traffic Chart of the Congested District (1915) shows the average number of vehicles per hour (totaling both directions) for each block of every street observed in the 1915 census. The vehicles are platted to a scale of 1,000 = 1 in. in width on a map of the territory drawn to a scale of 200 ft. = 1 in. Thus by comparing the relative widths of the black lines representing traffic we see at a glance the comparative volumes of traffic on different streets and different parts of the same street.

Results Shown by Census

The vehicular traffic in the downtown district, comparing the 1915 with the 1914 census, shows an increase of 20%, considering all classes. However, automobile traffic shows an increase of 53%—passenger automobiles increasing 56% and motor trucks increasing 41%. On the other hand, horse-drawn vehicles have decreased

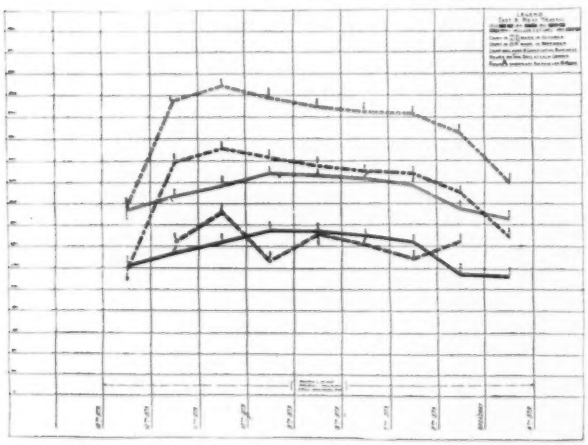


FIG. 5. AVERAGE TRAFFIC CHART

15%—one-horse vehicles showing a decrease of 17% and two-horse vehicles showing a decrease of 12%.

The remarkable one-year increase indicated in motor traffic is due to a certain extent to weather conditions prevailing at the time the census was taken. The counts in 1913 and 1915 were taken in October, during seasonable weather, while the count for 1914 was taken in November and ran into some pretty cold weather. For this reason largely, the 1914 count showed for the combined vehicular traffic only a slight increase over 1913. The number of state automobile licenses issued in St. Louis was 8,789 in 1913, 13,391 in 1914, and 16,362 in 1915. Present records indicate that the number for 1916 will be about 20,000. This shows 67% increase in the two years (from 1913 to 1915).

A count of standing vehicles in the downtown district was made in 1915. The count was for seven business hours one day and for four business hours the following day,

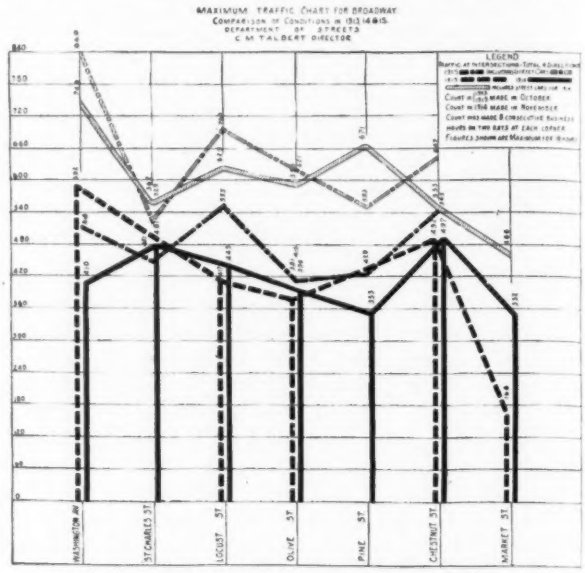


FIG. 6. MAXIMUM HOUR-TRAFFIC CHART

which happened to be a Saturday, and the count ended at 1 p.m. The count was taken at the end of October, and weather conditions were good. Observations were made in each block every hour, and the number of automobiles and horse-drawn vehicles standing on each side of the street was noted and recorded.

This information was compiled to show: (1) The average number of standing vehicles in each block during the 11 hr. observed, and also the block on the east and west streets and the north and south streets having the largest and the least number of automobiles, horse-drawn and all kinds of vehicles in 1914 and 1915 respectively; (2) the maximum number of standing vehicles observed in each block in the district and the time when it was noted. Finally there was prepared a map showing conditions in the downtown district, on which were platted approximately to scale the number of standing vehicles in each block together with the number of street cars observed in each block and also pedestrian lines, safety zones, etc.

It was found that the public streets were being used to store vehicles for a large part of the day, and from the data thus collected a parking ordinance was passed by the city which permits motor cars to stand for two hours only in the congested districts.

The study of traffic conditions, taking of census and making of regulations were initiated by and have been carried on in the Street Department under C. M. Talbert, formerly Street Commissioner and now Director of Streets and Sewers. For the first two years J. L. Laxton had immediate direction of the work, and for the past year it has been in the writer's charge. The City Plan Commission is now extending traffic observations out to the city limits on the main thoroughfares.

More Data on Test of Montreal Centrifugal Pump

By A. Peterson*

A report of a duty test made upon a steam-turbine-driven centrifugal pump at the low-level-pumping station of the City of Montreal was published in *Engineering News* of Apr. 27, 1916. The figures presented related principally to the conditions of operation and the over-all results, certain important data having been omitted in taking the results from the log of the test and others having been eliminated in editing. As these omissions have been made the basis of certain misinterpretations, it is believed that all available data useful for a critical examination of the thermodynamic results should be brought together. The latter have a certain interest because of the fact that the efficiency of the installation, including pump and auxiliaries, is believed to be higher than has before been obtained from a steam-turbine-driven centrifugal plant.

The pumping unit consists of a 14-stage impulse turbine, operated at 3,600 r.p.m. and driving through double-helical reduction gears a 30-in. centrifugal pump at 600 r.p.m. The turbine exhausts to a surface condenser of the water-works type—that is, with the water circulating outside the tubes. The condenser is equipped with a primary heater in the steam space, through which the water is forced by the condensate pump into an open feed-water heater receiving exhaust from the condenser dry-vacuum pump and from the condensate pump and additional steam bled from an intermediate stage of the main turbine.

The delivery of the pump was measured by a "Simplex" venturi meter having a 36-in. inlet and 21-in. throat, using a "Simplex" registering instrument, which was checked by a mercury manometer, the two agreeing within 0.2% difference, on the assumption that the coefficient of the venturi tube is 0.985. The water delivered from the open feed-water heater to the boiler-feed pump was measured by a "Cochrane" V-notch meter and by platform scales.

The points of attachment of the suction and discharge gages provided for by the specifications were such as to exclude credit for overcoming the friction through the following pipe fittings: On the suction side of the pump, one 42-in. gate valve, one 42-in. 45° bend, one water-works type condenser, one 42- to 36-in. reducing nipple, one piece of 36-in. pipe about 8 ft. long and one 36- to 30-in. reducing long-radius elbow; and on the discharge side of the pump, one 30- to 36-in. increasing long-radius elbow, one piece of 36-in. pipe about 9 ft. long, one 36-in. long-radius elbow, one 36-in. check valve and one 36-in. gate valve. During the test, readings of suction lift and discharge head were, however, also taken at the 30-in. suction and discharge nozzles of the pump.

The following data were given in the article published in *Engineering News* of Apr. 27, 1916:

Average water delivered, Imperial gal. per hr.	1,308,808
Average head at gage on discharge pipe, ft.	197.274
Average suction lift from water level to center line of pump, ft.	8.6
Total average corrected head, ft.	205.874
Average water horsepower	1,360.85
Steam consumption corrected for credits, lb. per hr.	17,344
Average absolute steam pressure, lb. per sq.in.	159.7
Average superheat at turbine, deg. F.	63
Steam consumption corrected to contract conditions (140 lb. gage and 100° superheat), lb. per hr.	16.638

In order that the test may be calculated according to the method given in the power-test code of the American Society of Mechanical Engineers for tests of complete steam-power plants the following figures are now added:

Average feed water, lb. per hr.	20,280
Average nozzle-pressure gage, lb. per sq.in.	138
Average vacuum corrected to 30-in. barometer	28.98
Average actual steam temperature at engine throttle, deg. F.	426
Temperature of feed water leaving heater, deg. F.	210
Steam per pump horsepower, lb.	12.74*
Total head generated, as measured by gages at suction and discharge nozzles, ft.	213.86

*This last figure was given erroneously in the original article as 12.7

The duty per million B.t.u., based upon the head measured according to the specifications, was 126.2 million foot-pounds. As the superheat, however, was only 63°, whereas 100° F. was specified, this figure was corrected by deducting from the steam consumption (17,344 lb.) 1% for each 9° F., or 4.1% in all, giving a duty of 129.6 million foot-pounds. The duty calculated on the basis of the work delivered by the pump to the water between the suction and discharge nozzles, making the same allowance for lack of superheat, becomes 134.6 million foot-pounds per million B.t.u. No correction is made because of the fact that the steam pressure was higher than the 140 lb. gage pressure specified, since the nozzle pressure was at all times below 140 lb. gage, and the turbine would have shown the same performance even though the steam pressure had been reduced.

The question has been raised as to whether, in stating duties of pumping units, the performance of the auxiliaries should be included with the performance of the main unit and whether credit should be allowed for heat returned in the feed water. Considering the manner in which the present apparatus was designed to operate, there can be no question that it is the over-all duty—that is, the work delivered in the water pumped, as compared with the net heat withdrawn from the boiler—in which the purchaser is primarily interested. Where the auxiliary exhaust cannot be used for heating the feed water, it should be admitted to some intermediate stage of the turbine, in which case it would be included in the turbine condensate. On the other hand, where there is not sufficient auxiliary steam to heat the feed water to the proper temperature, the efficiency of the unit is improved by extracting steam for that purpose from an intermediate stage of the turbine, which gives a more efficient heat cycle. The water rate is then obtained by measuring the water leaving the feed-water heater.

In an article by L. A. Day, entitled "Proper Methods of Testing Water-Works Pumps," which appeared in *Engineering News* of June 29, 1916, an attempt was made to determine the pump and turbine efficiencies implied in the results originally published. The approximate efficiency of the turbine, based upon the Rankine cycle, may be calculated from the data herewith presented, as follows:

First, to estimate the actual amount of steam going to the condenser.

If

N = Steam going to condenser in pounds per hour;
Q = Total amount of feed water, pounds per hour;
H = Total heat in B.t.u. per pound of auxiliary steam and steam bled;
r = Latent heat in 1 lb. of auxiliary and bled steam;
t_2 = Temperature of liquid corresponding to pressure of auxiliary and bled steam;
t = Temperature of condensate leaving condenser;
T = Temperature of feed water,

*Engineer, De Laval Steam Turbine Co., Trenton, N. J.

The following relation exists among the foregoing quantities (assuming no heat losses):

$X(T - t) = (Q - X)\ r + (Q - X)\ (t_2 - T)$, or

$$X = \frac{Q(r + t_2 - T)}{t_2 + r - t}$$

Let

$Q = 20{,}280$ lb.;
$t = 74°$;
$T = 210°$.

With 2 lb. back pressure on the auxiliary and bled steam, $H = 1{,}120$ B.t.u. (assuming adiabatic expansion and that part of the heat is recovered by reheating during expansion). Also,

$$t_2 = 218°$$

$$r = 1{,}120 - (218 - 32) = 934\ B.t.u.$$

We then obtain

$$X = \frac{20{,}280(934 + 218 - 210)}{218 + 934 - 74} = 17{,}720$$

$$Q - X = 20{,}280 - 17{,}720 = 2{,}560\ lb.$$

represents the amount of steam used for heating the condensate; in other words, the sum of the auxiliary steam and the steam extracted from the turbine.

The auxiliaries used about 450 lb. of steam per hour; accordingly the amount of steam bled was 2,110 lb. per hr. This steam did a certain amount of work in the high-pressure part of the turbine, which work can be calculated approximately by using the entropy diagram. The heat available in expanding from 145 lb. gage pressure, 63° F. superheat, to 2 lb. gage back pressure is 174 B.t.u., which gives a theoretical steam consumption of $\frac{2{,}545}{174} = 14.62$ lb. per hp.-hr., and assuming 65% efficiency of the high-pressure end of the turbine, the horsepower obtained from the bled steam was $\frac{2{,}110}{14.62} \times 0.65 = 94$ b.hp.

The total brake-horsepower delivered at the pump coupling, assuming 82% efficiency of the pump, is 1,725. (An efficiency of 82% is not impossible for so large a pump.) Thus from a steam flow of 17,720 lb. representing the amount of steam condensed, $1{,}725 - 94 = 1{,}631$ b.hp. will be obtained on a steam consumption of $\frac{17{,}720}{1{,}631} = 10.86$ lb. per b.hp.-hr.

The theoretical steam consumption for the steam conditions existing during the test (145 lb. gage, 63° superheat and 28.98 in. vacuum) is 6.9 lb. per hp.-hr. Thus the efficiency of the turbine and gears based upon the Rankine cycle is $\frac{6.9}{10.86} = 63.5\%$.[1]

From the above figures the gain in economy from the primary heater and bleeding steam can easily be estimated, as follows:

The total heat consumption of a standard 1,725-hp. turbine with independent auxiliaries will be

$(1{,}725 \times 10.86 + 450) \times 1{,}231 = 23{,}614{,}888\ B.t.u.$

The heat returned from the condensate and auxiliary steam, assuming a temperature of the condensate when leaving the condenser of 65° F., equals

$(1{,}725 \times 10.86 \times 33) + (450 \times 1{,}120) = 1{,}122{,}205\ B.t.u.$

Thus the net heat consumption is

$23{,}614{,}888 - 1{,}112{,}205 = 22{,}502{,}683\ B.t.u.$

With a primary heater in the condenser and bleeding steam sufficient to raise the feed-water temperature to 210° F., the total heat consumption of turbine and auxiliaries will be

$20{,}280 \times 1{,}231 = 24{,}964{,}680\ B.t.u.$

and the heat returned

$20{,}280 \times (210 - 32) = 3{,}609{,}840\ B.t.u.$

Thus the net heat consumption is

$24{,}964{,}680 - 3{,}609{,}840 = 21{,}354{,}840\ B.t.u.$

or a saving of

$22{,}502{,}683 - 21{,}354{,}840 = 1{,}147{,}843\ B.t.u.$

per hr., which represents an increase in efficiency of the complete installation of

$$\frac{1{,}147{,}843}{22{,}502{,}683} = 5.1\%$$

This saving is obtained through a very slight increase in cost of the apparatus, although should the saving be capitalized it will be found that a considerable increase in the original investment would have been justified.

Mr. Day also suggested that corrections be made to the readings of gages attached at the suction and discharge openings of centrifugal pumps, where the openings are not of the same size, as follows:

$$h = \frac{v_2^2 - v_1^2}{2g}$$

wherein

v_2 = Velocity through the discharge in feet per second;
v_1 = Velocity through the inlet in feet per second;
$g = 32.16$;
h = Correction to head in feet.

While theoretically correct, this formula should not be used without reservation, as the efficiency of the ordinary increasing fittings is not very high and instead of getting back all of the head represented by the formula the customer is more apt to gain only half as much. The one who benefits by the correction is of course the pump builder, who does not have to provide a diffuser as a continuation of the volute of his pump. He obtains the greatest advantage from this correction on low-head pumps, where the gain may amount to several per cent. In order to prevent this the specifications should be so drawn as to consider only pumps having suction and discharge openings of the same size, or to insure that the suction gage will be located close to the suction flange of the pump and the discharge gage at a point on the discharge pipe where it has been increased to approximately the same size as the suction opening.

Mr. Day stated that the high duty claimed for the Montreal pump was made on the basis of "no credit for friction head in the suction pipe, condenser and discharge pipe up to the city main." This statement is erroneous, but attention should be directed to certain desirable modifications in the general practice of drawing specifications covering this point. The manufacturer is often called upon to furnish, besides the pump, a certain amount of piping and fittings and is asked to assume the responsibility for friction in such piping and to make allowances therefor in the duty guarantee.

It would be better to require that the duty guarantee should be based upon pressure readings taken as close as possible to the suction and discharge flanges of the

[1] The efficiency of the turbine is in reality slightly higher, due to the fact that, owing to losses in heat transmission, the amount of bled steam is greater than figured from the formula given above.

pump and that the manufacturer should specify the friction head to be expected in the different fittings furnished by him, together with a description giving sizes, kind of elbows, length of straight piping, etc. It will then be easier for the customer to analyze and compare the different estimates and to place all manufacturers upon the same basis in reference to duty guarantees. Owing to the great difficulty in estimating the friction in fittings, two bidders may offer exactly the same piping and fittings, while estimating upon greatly different figures for friction.

Slaughter-House Sewage Test Plant, Buenos Aires

By Waldo S. Coulter*

The experience of the writer a few years ago with a test plant treating slaughter-house sewage at Buenos Aires, Argentina, may be of interest. This plant was installed September, 1911, at the Frigorifico Argentino, preliminary to the design and construction of an operative plant. Unfortunately, changes in administration and financial rearrangements intervened to prevent the entire completion of the operative plant.

The test plant consisted of a 2,500-gal. rectangular fill-and-draw plant settling tank; a sump communicating with the lower end of the settling tank by an adjustable weir; a small rotary pump, which elevated the settled sewage to a head box, and a sprinkling filter inclosed in a 15-ft. octagonal-shaped box, 11 ft. high, the upper 5 ft. acting as a wind shield.

The filtering medium was 6 ft. of ¾- to 1½-in. screened and washed coal. Coal was used because it was immediately available.

The settling tank was first operated as a plain sedimentation tank and was cleaned out weekly or oftener to keep the sewage fresh.

The head on the spraying devices was kept constant by pumping an excess to the head box and conducting the surplus back to the sump by an overflow trough. Variation of head for peripheral nozzles was secured by hand operation of controlling valves.

Observations were first made with upward jet nozzles of the Taylor and Birmingham types, the net rate being 800,000 gal. per acre per day at the commencement, which was gradually reduced to 335,000 gal. These net rates were secured by long resting periods, the rates of application, while the spray was in action, being 3,000,000 gal. and upward. At the end of two months' operation the filtrate would "stand up" for only 36 hr. at 15° C. and still retained a decided crimson tinge.

From close observation it became apparent that low rates must be secured by a low gross rate, not by application at comparatively high gross rates alternating with long resting periods. The upward-jet nozzles produced what was in effect a series of flushes through the filter at considerable intervals. If the aperture of the upward-jet nozzles was reduced sufficiently to give a low gross rate, clogging began at once, caused principally by flies which hovered over the tank and head box, or by any small object which happened to find its way to the nozzle.

Recourse was then had to downward jets with dash plates. It was found that these could be operated at the required low gross rates without clogging. By the use of long, tapered nozzles, with a head of 1 ft. or more above the nozzle point, a smooth, solid column of sewage could be projected downward upon the dash plate without shifting or producing an erratic spray. In conjunction with a suitable wind shield, dash plates as small as 1 in. in diameter, with correspondingly small nozzle apertures, gave good distribution over a wetted area 10 ft. or more in diameter. The optimum size of plate required varied with the diameter of the nozzle and the head on the same.

Tests showed the nozzle and dash plate finally fixed upon to have a distribution coefficient of 0.85 in still air, using Phelps' formula. By so spacing the nozzles that the underwetted peripheral areas will suitably overlap, a coefficient in excess of 0.9 in still air is practicable. For use in an operative plant, expansion joints would be required for the supply piping, in order to keep the nozzles over the plates.

Soon after the downward jets were installed, a marked improvement was noted, samples standing up from 55 to 60 hr., but the degree of purification was still inadequate.

This test plant was at all times supplied with washwater from the killing floors containing large quantities of blood, some manure and small pieces of fat and tissue. The fat content was small, this being mostly confined to tank liquors and tripe washings, etc., which were not treated. The washwater contained much so-called colloidal matter that it was not practical to remove by plain sedimentation, and it had been proposed from the first to resort to chemical precipitation in case ordinary sedimentation failed to effect a sufficient clarification.

The septic tank was not seriously considered, as it rendered the sewage so foul that subsequent distribution on a sprinkling filter would give rise to a nuisance. Furthermore, the septic sewage was of such a character that nitrification in a sprinkling filter was not practicable, as was subsequently demonstrated by trial.

It having become apparent that plain sedimentation was not providing sufficiently complete clarification, chemical precipitation was tried. Laboratory tests indicated that aluminum sulphate was the best precipitant, and to this was added a limited amount of ferrous sulphate, which was found to retard putrefaction of the sewage and produce iron sulphide in the sludge. It was expected that this would tend to prevent the formation of H_2S at the operative plant and reduce the probability of odor nuisance in connection with sludge handling.

*Of Hansen & Coulter, Consulting Engineers, 2 Rector St., New York City.

ANALYSES OF CRUDE AND TREATED SEWAGE FROM SLAUGHTER HOUSE AT BUENOS AIRES, ARGENTINA

Sample	Color	Odor	Nitrites	Nitrates	Chlorine*	Free Ammonia	Albuminoid Ammonia	Total Solids Fixed	Total Solids Organic	Organic Nitrogen	Oxygen Consumed
Raw sewage..	Deep red	Putrid	0	Trace	7,384	6,755	140	27,080	25,300	4,400	1,100
Tank effluent.	Reddish brown	Slightly putrid	0	Trace	11,780	....	...	43,920	11,760	2,360	590
Filter effluent	Light yellow..	None	24	231	12,560	840	126	42,280	3,900	520	130

*Chlorine was largely from NaCl in well water used for washing. Water from other sources quite free from NaCl was also used. The tank effluent and filtrate above represent well water, but toward the end of the day, when the raw sample was taken, water from other sources constituted a large percentage of the wash. It should be stated that these analyses do not accurately represent the condition of the samples at the time they were taken. At least 24 hr. elapsed between sampling and analyzing, probably much longer, and this during very hot weather, without provision for chilling or chloroforming the samples.

Alum was applied at the rate of 1,000 lb. per 1,000,000 gal., with 200 lb. of copperas. The tank effluent at once showed a marked improvement and, soon after, a light, straw-colored, nonputrescible filtrate was delivered.

The sprinkling-filter effluent showed no putrefaction after incubation for 7 days at 37° C., when tested by the Government chemists, and stoppered samples, stored by the writer at room temperature, were stable for an indefinite period.

The plant continued to produce an effluent of this quality until operation was discontinued. It was found possible to increase the rate at the sprinkling filter to 700,000 gal. per acre per day (net) without deterioration. It should be noted that the plant rested from 6 p.m. to 6 a.m. each day, duplicating the operative conditions.

The accompanying analyses, indicating the work done by the test plant, were made by the chemists of the provincial health authorities at La Plata. The filter effluent is of unusual interest, in view of its high organic nitrogen content and passage of putrescibility tests.

Drainage-Pump Foundation Design Is Dam Problem

By H. L. Hutson*

In a drainage-pumping plant, just as in a water-power plant, either the plant itself must form part of a dam or there must be a dam between the plant and its discharge channel or between the plant and its inlet channel. In water-power development the plant is usually located where there is a rocky formation in the stream and foundation conditions are apt to be favorable. But in the drainage plant the land is of recent formation and more than apt to contain stratified material such as vegetable matter, clay, silt, sand, shells, etc., none of which can be considered good foundation material.

Another difficulty to be borne in mind is that the drainage of the land within the district will alter the natural conditions by lowering the water level so that wood that has been preserved for hundreds of years may rot and quicksand that has been confined, or at least in stable equilibrium, may have a constant flow of water through it in the direction of the intake channel. There may also be a certain amount of hydrostatic head develop in porous or water-bearing strata so that it is undesirable to break the overlying impervious stratum because of causing springs, sand boils, etc.

Pumping Plant as a Dam; Curtain Walls

Not only the design of the foundations, but the location of the plant with respect to the levee, the elevation of the floor line with respect to high and low water levels, and the length of suction and discharge pipes will depend on the strata underlying the plant location.

One of the first requisites, therefore, in the design of a drainage-pumping plant is an accurate survey by borings of the plant site. Such a survey may indicate the desirability of looking for another site, but its chief need is to determine the location of the plant with respect to the levee and whether the plant itself is to act as a dam or whether the levee system is to be carried past the plant.

If there is an impervious subsoil that goes to a depth well below the greatest depth desired on the intake side, the plant itself may be designed as a dam and the suction and discharge pipes kept relatively short. Such a plant is shown in Fig. 1. This plant was located on what might be termed submerged prairie, where the subsoil was a stiff, impervious clay. The discharge canal was dredged across the plant site to a depth of perhaps 8 ft. below the floor line. The dam proper consists of an ample retaining wall on the discharge side of the plant. The foundations are tied into this wall, and the whole rests on round piles and is surrounded by sheetpiling that was used as a coffer-dam while installing the foundations.

If there is a porous stratum of moderate thickness, it may be shut off by a curtain wall or sheetpiling and the plant designed with short suction and discharge pipes and the plant itself as a dam. In this case great care is necessary to insure that the cutoff wall of sheetpiling or other material is in fact tight, that it is long enough to prevent seepage around the ends of the plant and that it makes an impervious joint with the underlying strata. The danger of this construction is that we cannot know to a certainty that we have cut off the flow, and there is a chance of gradual erosion undermining the plant and causing a failure after years of useful service.

Fig. 2 shows a plant where great care has been exercised to prevent danger from this cause. This plant was located on fairly firm ground, but where borings showed a stratum of porous material, such as broken shells, sand, etc., at a depth that would be exposed by the intake excavation. To prevent danger from this source, the plant was built within a permanent coffer-dam of Lackawanna steel sheetpiling, and wing walls of the same material were carried out from the corners of the building to serve the double purpose of cutting off seepage below and acting as a bulkhead above to prevent earth from falling into the intake. All these sheetpiles were 30 ft. in length. The concrete wing walls on the discharge side act as abutments for a bridge and are carried far enough to prevent wave wash from the discharge pipes. The space beneath the discharge pipes is filled with clay puddle.

Dams on Porous Foundations

If there is a porous stratum that will be exposed by the excavation of the intake canal or that may be exposed by subsequent scouring under the suction or discharge pipes, then the plant and adjacent levee should be considered as a dam on porous formation and designed accordingly.

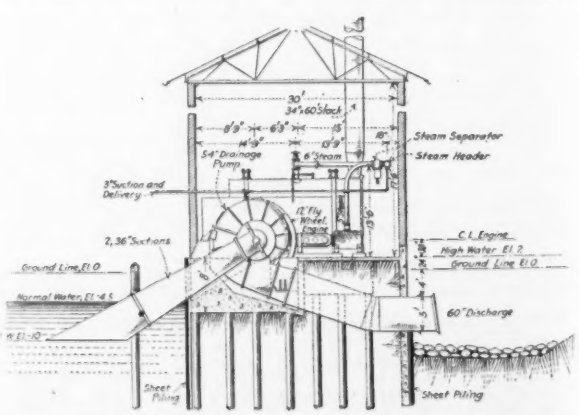


FIG. 1. ELEVATION OF WHITELAKE PUMPING PLANT

Reproduced from machinery manufacturer's layout and not intended to show actual proportion of foundations. Retaining wall at the front contains more concrete than indicated

*A. M. Lockett & Co., Ltd., 533 Baronne St., New Orleans, La.

The proper rules for the design of such dams have been given by W. G. Bligh (in an article in *Engineering News*, Dec. 29, 1910). The solution of the problem is to see that the water which seeps through the porous stratum under a dam has to travel a sufficient distance through this stratum for the friction to be great enough to prevent a flow of water that would move the material of the stratum. Mr. Bligh gives the following coefficients for the different porous material, where

H = Head or difference in water level above and below the dam;

L = Distance water would have to travel through porous material to render dam safe;

$\frac{L}{H} = C = 18$ for very fine sand and silt;

$= 15$ for fine sand;

$= 12$ for course sand;

$= 9$ for sand and gravel;

$= 4$ to 6 for boulders and gravel.

As an example, we will assume a plant for draining marsh lands where test borings show muck, 2 ft.; soft clay, 6 ft.; fine sand, 3 ft.; moderately hard clay, 8 ft.; and

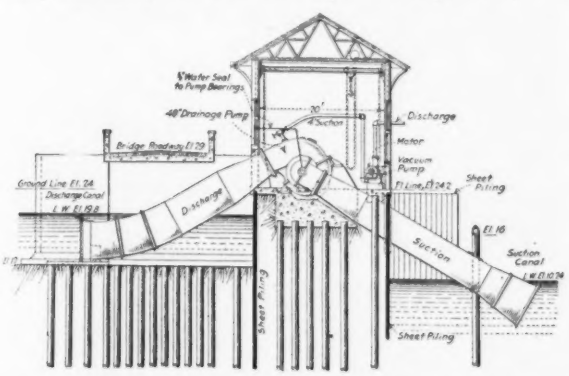


FIG. 2. ELEVATION OF NEW ORLEANS LAKE SHORE CO. PLANT

alternate layers of sand and clay for the next thousand feet. Such a plant may have a normal lift of 3 to 6 ft. with a maximum at storm tide of 10 ft. From Mr. Bligh's table, 18 is the proper "percolation factor." We have for the 10-ft. head condition that $L = 180$ ft. This means clearly that there must be 180 ft. horizontal distance between the end of the suction pipe and the end of the discharge pipe unless some other provision is made for increasing the distance L that the water must travel.

As Mr. Bligh has pointed out, where a cutoff wall or row of tight sheetpiling is used, the vertical distance that the water must travel both down and up in order to pass around this cutoff wall may be added to the horizontal distance traveled in figuring the length L. This will reduce the actual horizontal distance between the ends of the suction and discharge pipes. In the case of small plants with low lifts it would seem cheaper in many cases to depend only on the lengths of the pipes. In such a plant the use of moderately long suctions is advisable, as it places the plant some distance from the intake end and, if the plant rests on piles, permits cutoff of these piles at a higher level without danger of rot from the reduction of water level within the district.

In a report[1] recently prepared by engineers of the United States Department of Agriculture the problem to be met and its solution are very well stated. Fig. 3 is reproduced from this report, which states:

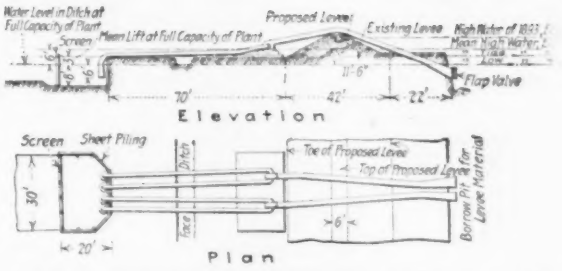


FIG. 3. COMBAHEE CORPORATION PUMPING PLANT

> Extensive borings in and around the pumping plant show that the first 8 ft. of material is a heavy impervious alluvial mud. This layer rests on a nearly level bed of fine, clean fairly sharp sand, which is very firm. It is believed that by placing the suction pit at a distance of 50 ft. from the pumping plant a greater protection from seepage will be assured than would be the case if the pit were placed adjacent to the plant and seepage intercepted by sheetpiling. According to the testimony of local parties, sheetpiling driven along the inside toe of the levee have been detrimental, as they have formed a channel for water to follow up through the impervious layer at the surface.

In this case it is evident that the sheetpiling around the intake pipes is intended only to prevent caving and would serve its purpose equally well were it equipped with weep pipes to prevent any water pressure behind it. Here, therefore, they depend solely on the horizontal distance between the suction and discharge pipes for resistance to undermining.

A condition where it is considered unsafe or undesirable to drive sheetpiles under a plant is unusual, but specifications were issued recently for a plant on the lower Mississippi where the engineer had such a wholesome fear of a known water-bearing stratum that he would allow no piles to be driven at all. In this case 400 ft. of discharge pipe was specified with 70 ft. separating the plant from the intake basin.

The Future Supply of Gasoline was discussed by Van H. Manning, Director of the Bureau of Mines, in an address at Washington, D. C., on Oct. 4. Dr. Manning said we are facing a serious condition in the petroleum industry. According to the U. S. Geological Survey, our future supply of petroleum is only sufficient to last us from 27 to 30 years at the present rate of consumption, without taking account of the increasing demand due to increasing use of automobiles and other machines driven by gasoline engines. The low price of gasoline a year ago was due to the tremendous production of crude oil rich in gasoline from the Cushing field in Oklahoma. This field which was producing 300,000 bbl. of crude oil a day a year ago is yielding less than 60,000 bbl. today. Cushing crude oil yields 25 to 30% gasoline. Crude oils now being used in place of the Cushing oil yield but 15 to 17%. The 2¼ million automobiles in use on Jan. 1, 1916, will increase, it is estimated by automobile manufacturers, to 4½ million by January, 1918. In addition, there is the increased use of gasoline in motor trucks, farm tractors, motor boats, etc. The automobile of today, due to improvements in the engine and carburetor, can use much heavier fuel than would have been practicable a year or two ago. The cracking process for converting kerosene and heavier oils into gasoline produced 2,000,000 bbl. of gasoline a year ago, and this year will produce more than 5,000,000 bbl. Tests made by the Bureau of Mines do not substantiate the claim that there is any considerable difference in the power developed from gasoline of different gravities. Tests in engines using gasoline from 74° to 60° showed a difference in the power developed of less than 2%. The engines using the heavier gasoline, however, were equipped to use it efficiently. If this is not the case, of course the lighter gasoline might give much better results. The Bureau of Mines is now preparing standard specifications.

[1] "Report on the Drainage of the Combahee Corporation Lands," by Charles W. Okey, Senior Drainage Engineer, and F. G. Eason, Drainage Engineer.

Water-Works Improvements at Sioux Falls, S. D.

SYNOPSIS—The new reservoir has novel floor construction and interior wells as its interesting features, and the new pumping plant is operated by oil engines that also drive electric generators.

Recent improvements to the municipal water-works plant at Sioux Falls, S. D., include a covered storage reservoir of 1,200,000 gal. capacity, two triplex pumps with 160-hp. Diesel engines and 135-kv.-a. generators, new electric lift pumps in the wells, and a 350,000-gal. elevated tank.

In 1915 the city authorities engaged Dabney H. Maury, consulting engineer, Chicago, to examine and report upon the water-works. His recommendations for improvements having been adopted, he prepared the plans and specifications. F. G. Gordon, as his resident engineer, supervised the entire construction. The city voted a bond issue of $140,000 for the improvement, and work was completed in April, 1916.

The city has a population of about 20,000, which is estimated to increase to 27,000 by 1930. At the time of Mr. Maury's investigation in 1915, it had about 42 mi. of 4- to 20-in. distribution mains, 3,581 service connections, 3,087 meters (91.5% of all active services being metered), 241 fire hydrants and 480 valves. The number of hydrants (about five per mile of main) was much too small for good fire protection. The average daily pumpage was 1,482,300 gal. and the maximum (for July) was estimated at 2,300,000 gal., while during sprinkling hours on the maximum day the water was being used at the rate of 4,400,000 gal. daily.

Water-Supply System

Sioux Falls was originally supplied by a private company, but some years ago the city built a competing plant, and the company was compelled to go out of business. The supply is obtained from wells in a water-bearing stratum of sand 20 to 30 ft. deep, which is covered by 4 or 5 ft. of loam and gumbo, and overlies a stiff, blue clay.

The quantity is abundant for many years to come, and the quality is good from a sanitary standpoint. The water is hard, however, and contains a large amount of iron (4 p.p.m.). The engineer recommended treatment for removal of the iron, and the authorities were strongly in favor of this improvement, but feared that if the cost of the iron-removal plant were included the bond issue might be voted down. The new reservoir, however, is built with columns of sufficient strength to support a treatment plant at some later time.

When first built, the city's plant took its supply by direct suction from a number of driven wells, but these proving inadequate, open wells were sunk. There are four open wells in the water-bearing stratum, located at distances of from 100 ft. to ¾-mi. from the pumping station on the outskirts of the city. Well No. 1 (at the station) is 25 ft. in diameter and 26 ft. deep. This was at first a supply well, but of late years it has served mainly as a pump well, receiving the water from the other three wells. No. 2 (1,600 ft. north) is 35 ft. in diameter and 28 ft. deep; No. 3 (2,400 ft. west of No. 2) is 50 ft. in diameter and 30 ft. deep; No. 4 (2,500 ft. west of No. 3) is 50 ft. in diameter and 32 ft. deep.

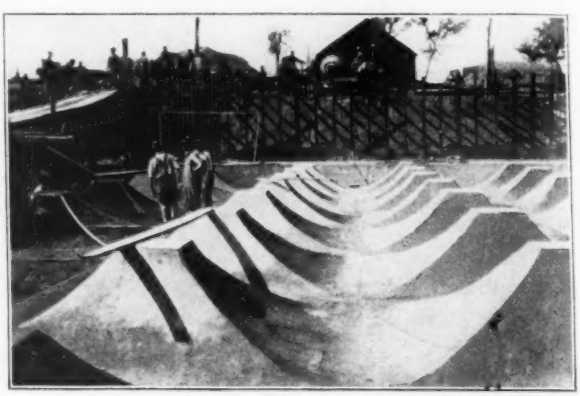


FIG. 2. GROINED-ARCH FLOOR OF RESERVOIR

The delivery to the pump well, No. 1, was formerly by siphon action, but to increase the supply the other three wells were later equipped with motor-driven centrifugal pumps. The pipe line has a rise of 27 in. from well No. 4 to the pump well. It is turned down to reach nearly the bottom of the latter well, and when the siphon is in operation a steam-driven vacuum pump is used to facilitate the siphon action by exhausting any air that may collect in the upper end of the pipe. The engineer recommended that the plant should be made capable of supplying for domestic purposes 3,000 gal. per min. distributed throughout the city at pressures adequate for lawn sprinkling in the higher parts of the city. Also that it should be capable of supplying for four hours for fire purposes 3,000 gal. per min. in the congested-value district, or 2,000 gal. per min. in the residence district.

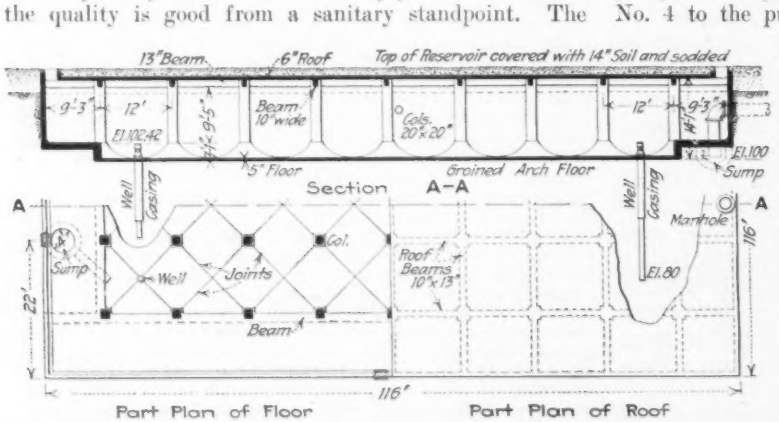


FIG. 1. RESERVOIR WITH GROINED-ARCH FLOOR FOR CITY WATER-WORKS OF SIOUX FALLS, S. D.
Note the wells in bottom of reservoir

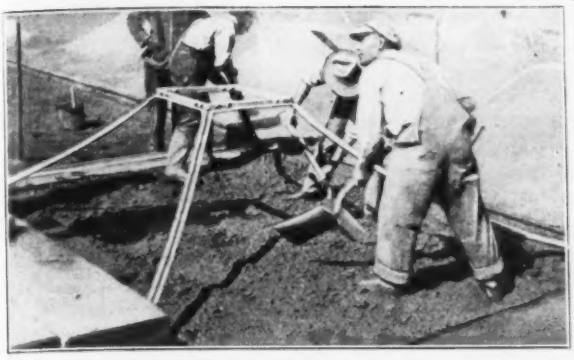


FIG. 3. FRAME USED FOR GROINED-ARCH FLOOR

The three supply wells noted could not supply more than 2,000,000 gal. daily by siphon action alone, and the lift pump equipment in the wells was not satisfactory. By placing adequate pumping machinery in these wells, and drawing also upon well No. 1, it was estimated that it would be possible to develop a supply of 4,200 gal. per min. (6,000,000 gal. per day) even during dry weather. This plan was adopted and each well now has a vertical-shaft submerged centrifugal pump driven by a 20- or 25-hp. motor.

Covered Storage Reservoir of Concrete

To enable the wells to maintain a supply sufficient for fire and domestic requirements, a storage reservoir of 1,200,000 gal. capacity has been built near the pumping station. This reservoir is of concrete, 116 ft. square, and 10 ft. deep, with its top about 15 in. below the finished surface of the ground. As the bottom is below the ground-water level, the floor is of the groined-arch type in order to resist upward pressure. Columns spaced 12 ft. c. to c. support a slab and girder roof. This reservoir was built by Fanebust Brothers, of Sioux Falls, at a contract price of $15,956. There were no extras.

The construction of the reservoir is shown in Fig. 1. The first portion built was a bottom slab 6 ft. wide on each side, these slabs taking the thrust from the outer lines of groined arches. The walls were then built, the surface of the construction joint being first thoroughly cleaned.

In building the floor, each column seat formed the center of a panel, which was in effect a truncated pyramid with curved faces, as shown in Fig. 2. The more usual practice has been to lay out the panels with dividing lines through the column seats. This method involves construction joints centering under the column. In other words, the column rests on a pedestal or footing divided in both directions by these construction joints. By the method described above, each column rests on the center of a solid block.

This method was devised by the contractor and was carried out by the use of light skeleton frames, as shown in Fig. 3. Each frame consisted of a top and bottom square frame of the size of the top and bottom of the block or panel, with four corner angles curved to the shape of the groined arch. These light frames were easily placed. Fairly stiff concrete was placed within them, and a wetter mix formed the surface, which was then screeded or struck to the required curved shape, using the corner angles of the form as templets.

The concrete was made in a mixer at the ground level and distributed by wheelbarrows, being dumped from the barrows into the forms. All reinforcing steel was cut and bent at the mill. The contractor used a commercial spacer for all bars in the roof, and special devices of his own to keep other bars in correct alignment. Excellent results were secured in this way. The excavation was done by slip and wheeled scrapers, which were driven up an inclined roadway and dumped the material into piles for future use in grading, etc.

The bottom of the reservoir excavation being about 3 ft. below ground-water level in the gravel bed while the work was in progress, steps had to be taken to enable the work to be done in the dry. The novel plan adopted by the consulting engineer was to drive within each corner of the site a 10-in. well extending about 20 ft. below the bottom of the excavation. These were blown out with a steam siphon to get them clear of sand, and were then connected to the main pumping plant, and pumped continuously. In this way they served the double purpose of lowering the water level during construction and affording an additional supply of water for the city. The wells proved sufficient at all times to keep the ground-water level below the bottom of the excavation, even after very heavy rains.

These wells are maintained permanently, and now serve the additional purpose of preventing excessive upward pressure on the floor of the reservoir. Each is fitted with a check valve which prevents the escape of water from the reservoir, but in case the water level in the reservoir

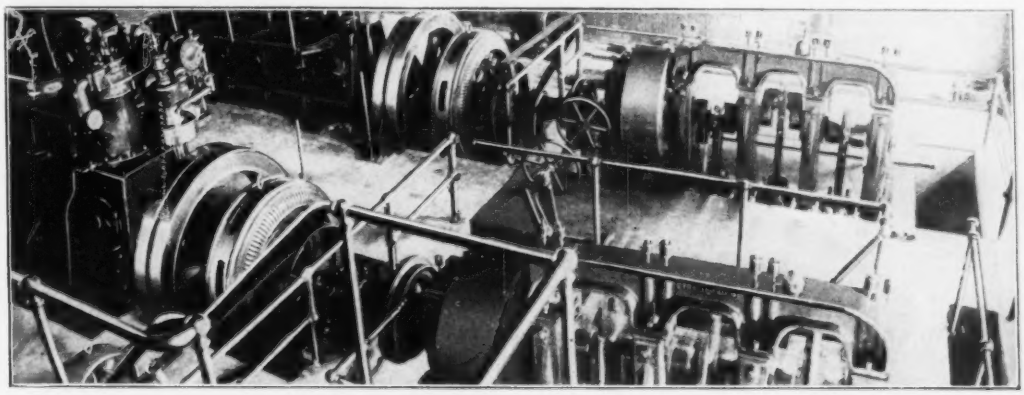


FIG. 4. PUMPING PLANT AT THE WATER-WORKS AT SIOUX FALLS, S. D.
Each unit consists of an oil engine at the left, a generator and a triplex pump

should be lowered by heavy pumping, the ground-water pressure will open the valves and admit water into the reservoir.

Pumping Plant, Etc.

Previously to the new improvements, there were two steam pumping engines, each of 3,000,000 gal. daily capacity: A Holly vertical triple-expansion engine with surface condenser, and a Snow horizontal compound duplex engine with jet condenser. The latter is usually run noncondensing owing to the large amount of cooling water required to be taken from the mains. Connected to the distribution system was a standpipe and an elevated tank. The former was 115 ft. in diameter and 20 ft. high, of 275,000 gal. capacity. The old tank is of 230,000 gal. capacity, 29 ft. in diameter and 36 ft. high, on a steel tower with a height of 129 ft. from base of tower to top of tank. The tops of the standpipe and tank are at the same elevation, giving a pressure of 72 lb. at the pumping station. For the 108-lb. fire pressure the standpipe and tank are shut off by hydraulic valves controlled electrically from the pumping station.

The new oil-engine pumping plant will practically supersede the Snow engine. It consists of two Aldrich triplex pumps, each driven by a 160-hp. Diesel oil engine of the Busch-Sulzer type. The capacity of each pump is 1,500 gal. per min. against a head of 190 ft. for domestic service and 260 ft. for fire service. Each engine has a 135-kv.-a. generator mounted on its shaft, furnishing current to operate the lift pumps in the supply wells, the current for which was formerly purchased from a power company. These generators are also available for helping out the city lighting. The engine shaft is connected through a clutch coupling to the crankshaft operating the pumps.

The fuel oil is stored in two horizontal cylindrical tanks of 11,500 gal. capacity, housed in a separate building equipped with heaters. From these storage tanks it is pumped to a 30-gal. supply tank in the engine room. During the test the fuel consumption was 10 gal. per hr. with the pump delivering 1,500 gal. per min. against an average head of 170 ft. and the generator delivering 10 kw. This plant has worked very satisfactorily.

The 16-in. cast-iron delivery pipe from the pumps makes both a horizontal and vertical curve near its connection to the pumps. To prevent blowouts, all joints where the pipe changed direction were fitted with clamps and tie-rods.

A new steel water tower, built by the Chicago Bridge and Iron Works, supplements the old standpipe and tank. This has a 350,000-gal. tank with elliptical bottom on a six-post tower, the height being 96 ft. from top of pedestal to the flow line of the tank. A 6-ft. riser pipe supplies the tank.

Other improvements include about five miles of 4-in. to 16-in. distribution mains.

Rules for the Use of the Dry Docks on the Panama Canal are published in the "Panama Canal Record" of Oct. 4. The new dry dock at Balboa is 1,000 ft. long and 110 ft. wide, with a depth of 35 ft. over the blocks at mean tide. The dock at Cristobal is 300 ft. long, 48 ft. wide, with a draft at mean high water of 13 ft. 6 in. over the blocks. The rates charged for use of the docks are at the Balboa dock 25c. per ton for docking and undocking, and 15c. for each lay day. At the Cristobal dock these charges are 15c. and 10c. In addition, minimum charges are fixed for vessels of small size.

Obsolescence in Appraisals for Rate Making

By C. C. Harshman*

To determine the amount of money that must in any year be set aside from the revenues of a public-service corporation in order to secure the integrity of the corporation's investment and at the same time work no hardship on either consumers or the corporation because of excessive or of confiscatory rates for service, a careful consideration is required of the rate at which the component parts of the plant become unfit for further service.

Any given element of the plant becomes unfit for further service in two ways: (1) By physical deterioration or wearing out; (2) by becoming obsolete—(a) either through advances in the manufacture of more efficient units so that it is unwise from an economic standpoint to longer operate the installed unit, (b) from insufficient capacity due to large growth of the plant, (c) through legislative action.

The general subject of depreciation has been discussed at great length by engineers engaged in valuation work. Probably most of the difference in opinion concerning, and difficulty in handling, the subject is occasioned by the fact that the distinction between true depreciation and obsolescence has not been recognized and kept in mind, but those two elements have been lumped together for consideration and loosely termed depreciation. Since true depreciation is a function of time and obsolescence is not, the sum of the two is not a function of time, but varies from it just enough to cause different considerations of it as a function of time to vary greatly. Obsolescence should be considered separately from deterioration.

Obviously, those who are consumers served by a public-service plant should pay during the life of any piece or part of that plant, through the rates they are charged for service, an annuity that will have completely reimbursed the corporation, at the end of the element's natural life, for the cost of purchasing, installing and removing[1] the piece or part that is being worn out.

Were it possible accurately to forecast the period of usefulness of the different component parts of a plant, this reimbursement could be easily accomplished. The length of time it would take any given part to become unfit for use from wearing out can in general be quite closely estimated from past experience. It is, however, impossible to estimate with any degree of certainty the period within which that same part of the plant may become useless due to one or more of the last three causes.

Thus it becomes necessary, is by no means unjust and is indeed exactly proper that the consumers for a given time after a part has become useless from any of these three forms of obsolescence should pay, in their rates, an annuity necessary to reimburse the corporation for such part of the expense of placing the superseded element in service and removing it as has not been taken care of in the fund built up from the depreciation annuity allowance.

In this way during the time any piece is in useful service those who are consumers and are receiving the service that piece is giving are paying an annuity based

*Valuation Engineer with H. T. Cory, Nevada Bank Building, San Francisco.

[1]The cost of removing will be a credit if the scrap value exceeds the expense of taking out. In any event, this cost should not go into capital account; otherwise the latter will depart from the true value of the plant.

on the assumption that the part will have what might be styled "normal" useful life; and those consumers who receive service after that piece has been replaced by another better piece at an earlier time than the state of physical deterioration of the superseded part would have necessitated and who thus receive the advantage, through rates or service or both, of the replacement are paying an annuity that compensates the corporation for the difference between the cost installed of the part superseded, less whatever value it had as salvage, and the amount that had accumulated from the annuity payments during its life.

As an example, consider that a piece of transmission line had cost $1,000 and that, as a result of legislation, the poles and crossarms had to be replaced by higher poles and longer crossarms, but that the wire was fit for further use reinstalled on the new line. Suppose the original cost had been subdivided into poles, crossarms, etc., $600; wire, $400; total cost installed, $1,000. Further, consider that the normal useful life of these two parts had at the time of installation been so estimated that, at the date of the change, the sums collected from the annuities covering these items amounted with interest to $500 and $150 respectively. Thus the so-called "present value" of these at the time of reconstruction—taking "present value" as the difference between "original cost" and "amount in fund"—would be $100 and $250 respectively. As a measure of actual present value these figures are subject to criticism, but they do represent the portion of the original expense in installing these items for which the corporation has not been reimbursed. The company is fairly entitled to some arrangement that will reimburse it.

Consider further that the new line cost, exclusive of the wire, $850 and, for simplicity, that the scrap value of the poles, crossarms, etc., just equaled the cost of removing the old line. The condition is then:

	Original Cost	Amount in Fund	Original Cost Less Amount in Fund	Cost New Line
Poles, crossarms, etc...	$600	$500	$100	$850
Wire	400	150	250	250
	$1,000	$650	$350	$1,100

The proper procedure would be to credit capital with the $1,000, or if the depreciation had been annually credited to capital, with the $350. The capital account should then be charged with $1,100, being the cost of the new work. The obsolescence fund should be charged with $100, being the original cost less salvage value, minus the amount in fund, or ($1,000 — $250) — $650 = $100.

The obsolescence annuity must be such that the same rate of interest can be paid on the obsolescence fund as is used in making up the allowable rate of return on the capital invested, in addition to whatever part of the fund it is desired to retire during that year. In case the conditions are such that only a very small annuity can be set aside annually, it simply means that the amortization of the obsolescence fund will be spread over a greater number of years. As the number of years over which the amortization is spread is increased, the condition, as far as the rates to be charged are concerned, approaches that which would be in effect if the obsolescence fund had been charged to capital. The limiting conditions are:

1. Where the business is so prosperous that all of the fund can be charged off with interest in a single year—which is equivalent to charging the obsolescence into operating expenses, which is frequently done.

2. Where only the interest on the obsolescence fund can be carried by the rates that are possible—this is equivalent to charging the obsolescence to capital, as is also sometimes done, with the very important exception that, when the business has become such that more than the interest on the obsolescence fund can be paid, the fund itself may begin to be charged off and not, as if it were charged to capital, be a penalty for all time against the rate payers, interest on which they must always pay.

When a new company is unable to earn its full just rate of return, the difference between the amount that it does earn and the amount that it is entitled to earn is charged to capital under the head of development expense, or some such item. Similarly, if there cannot be provided from the rates possible at a given time an annuity sufficient to pay even the full amount of interest on the obsolescence fund, then the difference between that interest which is paid and that interest to which the fund was entitled must be charged into the fund itself, to bear interest at the same rate. When the business of the company improves, the annuity may be increased sufficiently to retire the fund.

This last phase of the matter is in individual cases frequently of great importance. In certain instances the opportunities for increasing the sales of the commodity are at present limited, but will at some future time be large enough to yield substantial profit. At the same time, much inefficient and obsolete equipment may now be in use which for economy's sake should be replaced at the present time. In such cases it might well be possible that rates which would provide for amortizing such obsolete equipment at present would be prohibitive, killing off what meager business the utilities might now have. However, this is no reason why obsolescence should be charged into capital for rate payers to pay interest on for all time. Nor is it, either, any reason why the utility should lose the money remaining in the investment, which was, when made, strictly in accordance with what was considered at that time good engineering practice.

By charging the obsolescence into the obsolescence fund and disposing of it as suggested, with whatever rapidity a careful investigation might indicate advisable, both of these errors, the one unfair to the rate payers, the other to the utility, would be avoided.

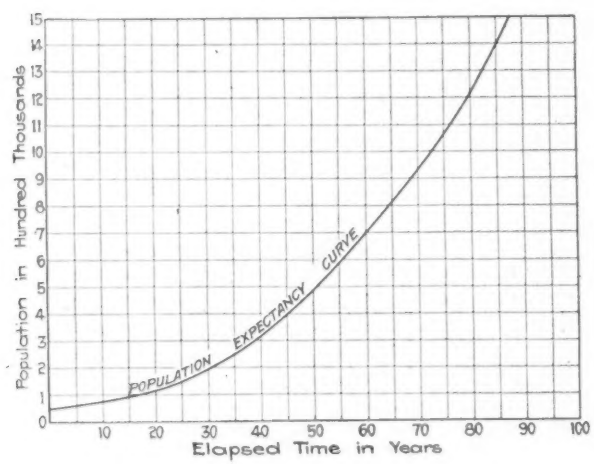
A Ladder Dredge for Excavating Snow on the line of the Chilean Trans-Andean Ry. has been designed by William T. Lucy, of the road's engineering staff, and was described by him in a paper entitled "The Working of a Rack Railway" read before the Institution of Civil Engineers. This railway is already equipped with a Leslie rotary snow plow built by the American Locomotive Co., but Mr. Lucy states that in deep cuts when the snow is filled in to a greater depth than 15 ft., the Leslie plow does not work well, as snow has to be shoveled off by hand from the top of the cut. More serious trouble is experienced when a deep cut is filled with snow by an avalanche, as pieces of rock are often brought down with the snow and cause much damage when struck by the rapidly moving blades of the rotary excavator. Mr. Lucy has therefore designed a snow-clearing machine consisting of two parallel ladders carrying endless chains of buckets of the pattern usually employed for excavating stiff clay. The snow excavated by these buckets is discharged into a hopper, from which it is discharged by gravity upon a centrifugal ejector which throws it either to the right or left of the track as required. The approximate weight of the machine is about 60 tons. The Chilean Trans-Andean Ry. has not yet been financially able to purchase the machine, but intends to try it as soon as circumstances permit.

Population Studies by Moore Expectancy Curve

By George Holmes Moore*

What the author has named the Moore expectancy curve is a graphical representation of the population a city may be expected to have after any given elapsed time in years. The curve is derived by plotting on cross-section paper the actual populations of selected cities after equal periods of elapsed years, ignoring exact dates and choosing such values for "elapsed time in years" as may enable the respective curves to conform most nearly to a final mean value for the group. After the several curves have been plotted, the mean or composite curve is sketched in. This alone is traced off on transparent paper, as shown in the accompanying diagram, for use by itself or for superimposing upon other curves for various comparative purposes.

To illustrate a simple use of the curve: Suppose one desires to obtain the most probable population that a



MOORE EXPECTANCY POPULATION CURVE
On the original each year and each 10,000 population were shown

city of 500,000 will possess after a lapse of 20 years. It is necessary only to mark the 500,000 point on the expectancy curve, add 20 years to the elapsed time, which in this case will give a final of 71 years, and read off 960,000.

The method can be used in almost every problem that involves either population estimate or population analysis. It can be used to predict the most probable population of a city of any size whatever at any given future time. Or, on the other hand, by comparing the plotted curve for any city with the expectancy curve it becomes evident at a glance whether the city in question is growing, or has grown, faster or slower than the average of its class.

Finally, it will be evident after a little reflection that analyses based on the expectancy-curve method are exactly as reliable as are insurance risks written on the basis of mortality tables. And since by its use the three quantities of maximum, minimum and mean populations to be provided for are readily obtainable, it is claimed that the expectancy curve provides a thoroughly defensible method—possibly the first—for the exact analysis of population problems.

*City Hydrographer, Seattle, Wash.

Experience in Paving Roads of a Washington County*

By David H. White†

Pierce County has 64.39 mi. of hard-surfaced roads, completed and under construction, exclusive of macadam roads, which method of construction has been found unsatisfactory and has been abandoned. There are seven different types of pavement: Granitoid, sheet asphalt, one-course concrete, Bitulithic, Warrenite, brick and Bitucrete. In order to determine which is the most economical and satisfactory, a complete permanent cost record is kept of both construction and maintenance on each contract section. All the pavements are constructed without bonded or other indebtedness.

Some of the items kept on record as a part of the cost sheet are: Cost of common labor per day; cost at mill of cement and freight on cement; cost of gravel at bunkers and freight on gravel; cost of sand at bunkers and freight on sand; cost of crushed rock at quarry and freight on rock; asphalt f.o.b. Tacoma and freight on asphalt; traffic census; condition of pavement; probable life of wearing surface; ultimate renewal value per square yard; cost of right-of-way; probable annual maintenance per square yard.

Remarks on Various Types of Pavement

Granitoid Pavement—Pierce County has 8.009 mi. of Granitoid, costing $1.40 per sq.yd. without subgrade and extras. This pavement consists of 4½-in. concrete base of 1:3:6 mixture and a 1½-in. top of 1:1½ mixture, the stone in the surfacing being: 50%, ⅜-in.; 25%, ¼-in.; 25%, ⅛-in. All smaller material is removed. From present indications this pavement is not equal in value to our best one-course concrete pavements, costing considerably less, and is not recommended in future construction.

One-Course Concrete—There is 21.8501 mi. of one-course concrete paving, costing exclusive of subgrade and extras, 85.6c. per sq.yd. In addition to this we are now building 1.836 mi. in conjunction with the Western Washington Hospital for Insane. A number of paving methods are being used in this pavement, the idea being to experiment with all the different approved types of construction so as to determine the best. One method being tried is that used in Sioux City, Iowa, described in *Engineering News*, July 27, 1916.

In repairing concrete pavement where holes have appeared all loose concrete was removed and the edges were squared up so that the sides were perpendicular; then an additional 2 in. was excavated, making a depth of 7 in. The hole was cleaned out and the bottom thoroughly tamped with a 50-lb. tamper. Crushed rock varying from ¾ to 2½ in. in size was well tamped into the hole and coated with approximately 1½ gal. of "D" asphalt per square yard, after which a second layer of crushed rock of sufficient depth to bring the surface to grade, after tamping, was placed and coated with approximately 1 gal. of asphalt per square yard.

The patch was covered with screenings and left for traffic to pound down for a couple of days, after which it was swept clean and 1 gal. per sq.yd. of "E" grade asphalt was spread and well coated with screenings. The

*Based on a paper read before the meeting of the Washington Association of County Engineers, Sept. 14 to 17, 1916

†County Engineer of Pierce County, Tacoma, Wash.

rock used was thoroughly dried on a half-section of metal culvert pipe over a fire.

The cost of repairing 571 sq.yd. in this manner was $1.49 per sq.yd. This was done by county forces. A similar kind of patching was done by one of the asphalt companies at a cost of $3 per sq.yd.

The one-course concrete pavements hitherto laid in this county have practically all been built under two different specifications, one being a 1:2:4 mix on a curved subgrade and 5 in. thick, the other a 1:2:3½ mix with a flat subgrade and a thickness of 5 in. at the edge and 7 in. at the center. The latter construction has proved so far superior to the former that we do not consider using the older specification.

Monolithic Brick—This office has abandoned the old-style specifications for brick pavements, which usually provided for a 1½-in. sand cushion between the concrete base and the brick. We now specify only the monolithic construction, wherein the brick is laid directly on the fresh concrete without the intervening sand cushion. The base course of concrete is laid; and immediately before the concrete begins to set, a ½-in. layer of sloppy 1:3 mortar is spread over the fresh concrete. The bricks are laid directly in this mortar, leveled by light tamping and grouted with a 1:1 mixture.

Pierce County has 0.744 mi. of brick paving (on sand cushion) costing $1.79 per sq.yd. exclusive of subgrade and extras.

Bitucrete—We are now building 6.066 mi. of Bitucrete paving on the National Park Highway, or Mountain Road, at a contract price of $1.29 per sq.yd. exclusive of subgrade and extras. A 1:3:6 concrete base 5 in. thick is used, and on it asphalt heated to from 200° to 250° F. is spread evenly to a sufficient depth to give the quantity of asphalt required to fill the voids in the aggregate, which consists of rock or gravel passing a ¾-in. ring, and clean and well-graded sand mixed in the proportion that will obtain maximum density and low percentage of voids.

This aggregate is heated in a drier to a temperature sufficient to melt the asphalt and draw it up by capillary attraction. The heated aggregate is spread over the asphalt to such a depth that, after firmly compacting it by rolling, the wearing surface is 1 in. thick. After the asphalt has been liquefied and drawn up by capillary attraction, the pavement is again rolled with a five-ton roller until there is no appreciable compression. A flush coat of hot asphalt is then applied, on which fine aggregate heated to between 300° and 400° F. is spread, and the pavement is again rolled.

Sheet Asphalt—Pierce County has 8.47 mi. of sheet-asphalt paving, the average cost without subgrade and extras being $1.587 per sq.yd. A portion of this pavement 4½ mi. long became so slippery after every light rain that hundreds of accidents occurred, and five persons lost their lives.

To remedy this condition the pavement was covered with Roadamite and sand. No trouble has been reported since. The 90% Roadamite was used, ¼ gal. per sq.yd. being applied with a pressure distributor. The oil was heated to from 250° to 350° F. The entire surface was then sanded with coarse washed sand, using 1 cu.yd. to about 108 sq.yd. of pavement. This treatment cost 6½c. per sq.yd.

The Roadamite had the following analysis: 90% residue had a penetration of 77 at 70° F.; Osborne test for adhesiveness, 1,290 sec.; flash point, 338° F.; burning point, 415° F.; solubility in carbon tetrachloride, 99.9%; solubility in carbon bisulphide, 99.9%.

Bitulithic and Warrenite—There are 15.5448 mi. of Bitulithic and 3.709 mi. of Warrenite, costing respectively, without subgrade and extras, on an average of $1.377 and $1.48 per sq.yd.

The foundation was crushed rock, macadam, concrete or what is known as "black base," an asphaltic concrete. The difference between Warrenite and Bitulithic is slight, some of the specifications being identical, with the exception that not to exceed 25% of gravel is to be used in the Warrenite pavement. The Warrenite is usually the cheaper pavement.

Gravel and Earth Roads

Pierce County has about 200 mi. of earth roads, the average cost for construction in 1915 being $1,156 per mi., and about 300 mi. of graveled or spread crushed-stone roads costing in 1915 an average of $1,850 per mi., of which labor was 89%, powder 6% and culvert pipe 5%. The average cost of grubbing in an ordinary timbered country was about $170 per acre for a number of jobs in this vicinity. These roads were built from 12 to 24 ft. in width, with a crown of 1 in. per foot of width, particular care being taken to provide good side ditches for drainage. Deep ditches, being dangerous to traffic and easy to fill up, are not recommended, and wide shallow ditches are required. Corrugated-metal culverts are allowed in remote districts, but in all paving contracts concrete pipe is specified.

A grading machine propelled by horses gives very satisfactory results and costs on our prairie soils or similar locations about $150 per mi., but in many cases where a steam roller is the tractive power better results are gained on account of the compacting power of the roller. Where a road is well shaped, the steel drag is used to preserve the crown of the road and keep the surface free from ruts.

The best piece of earth road discovered in this vicinity is a stretch of the National Park Highway between the Mashel Bridge and La Grande. This road is in fine condition during both winter and summer, with but little maintenance. In collecting material for graveling the road a portable sand tester was used and has been found very satisfactory. An analysis of the surfacing material in this road, made with the portable sand tester, gives the following results:

SAND FROM LA GRANDE—MECHANICAL ANALYSIS

Pass No.	Pit, % Passing	Road, % Passing
200	4.1	6.4
100	8.0	8.1
80	6.6	4.7
50	16.3	7.4
40	13.1	6.9
30	10.2	6.5
20	14.7	12.1
10	14.5	12.7
8	2.6	3.4
4	5.2	9.5
2	3.5	8.3
¾-in.	1.2	5.7
	100.0	
1 -in.		1.9
1¼-in.		6.4
1½-in.		
		100.0

Testing Laboratory—Pierce County has a testing laboratory for the purpose of testing cement and bituminous mixtures and making volumetric analyses of sand, gravel and crushed rock. This department has proved itself very successful and satisfactory.

Notes from Field and Office

Keeping clearance unobstructed while building a concrete crossing—Bending expanded metal on job—In October rails were oiled on 950 miles of track to prevent corrosion—A canvas coffer-dam—How 41 railways handle small concrete jobs—Culvert for 150-ft. fill—Fill shrinkage

Arch Centers Suspended from Old Plate Girders

In the construction of a reinforced-concrete arch bridge crossing over the Lackawanna R.R. at Millburn, N. J., the right-of-way was kept clear of falsework by suspending the arch forms from plate girders spanning the abutments. This part of the line is subject to very congested commuting traffic in morning and evening on all three of the tracks, so that it was highly desirable that the usual falsework posts be omitted. Rather than use steel arch centers (which would reduce the top clearance to dangerous limits) or attempt to space falsework posts for clearance, the engineers decided to suspend the forms from above, utilizing an abandoned plate-girder bridge that could readily be brought to the site.

FIG. 1. OVERHEAD BRIDGE ON LACKAWANNA R.R. CONCRETED IN SUSPENDED FORMS

The accompanying views and sketch show the details of construction. The arch is on a skew with a single rib carrying an earth fill between gravity spandrel walls. The abutments and the arch were constructed first, the arch being carried up to the limit of its overhang on segmental forms supported from struts footing well outside the outside tracks. The arch rib was finished here with jogged skewbacks normal to the line of thrust. The intervening section, 45-ft. span, was carried by the suspended centering.

On the abutments there were then placed the four plate girders. Each girder was about 60 ft. long and 6 ft. deep. The outer two were blocked up on the side walls of the abutment and the middle two on piers purposely cast on the slope of the abutment. After the girders were up, their floor-beams were bolted in place in the outside two of the three openings; on their lower flanges 12x12-in. timber stringers were rested, four stringers to each of the three floor-beam openings. In the middle opening, timber cross-beams resting on the flanges of the main girders were used instead of the steel floor-beams. This arrangement is shown by Fig. 2.

The stringers acted as the main carriers of the centering, which consisted of 3x3-in. angles shaped to the arch curve and running lengthwise of the bridge. These were hung from the stringers by ¾-in. rods spaced about 3 ft. c. to c. and carried transverse 2-in. lagging, which was additionally held by spiking on crosspieces and braces. The suspender rods were covered with tubing so that they could be readily removed when the arch concrete had reached a proper set.

The method proved very successful, and more economical than using steel ribs embedded in concrete.

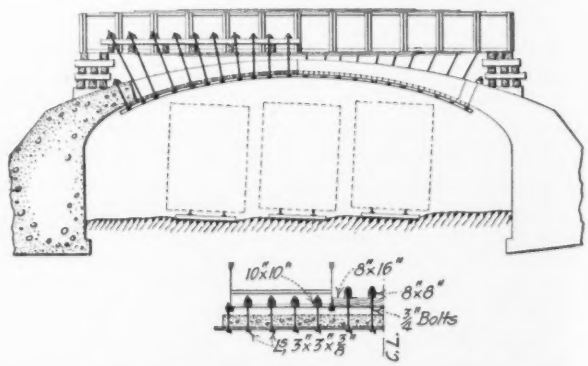


FIG. 2. DETAILS OF METHOD OF SUPPORTING MILLBURN ARCH ON SUSPENDED CENTERS

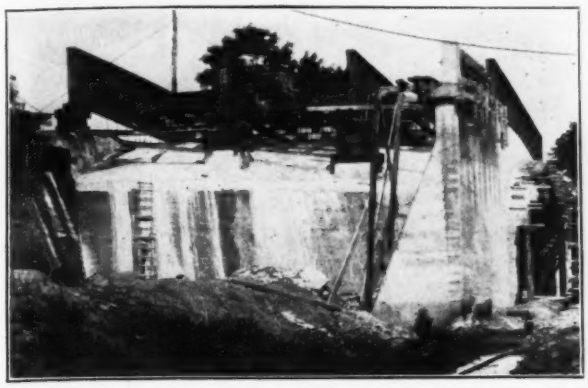


FIG. 3. VIEW IN REAR OF MILLBURN ARCH

considering the high cost of such steel at the time this work was done. The proper curve could be readily controlled by the screws at the top of the suspender rods and the arch easily sprung by the same method. It was found that the suspension girders were somewhat too close to the top of the rib for easy concreting, but this is a matter of detail that can be corrected in future similar work.

The bridge is being built for the Lackawanna R.R., George J. Ray, Chief Engineer, by James A. Hart, contractor, of New York City. G. B. Barackman was assistant engineer in charge of construction, under G. T. Hand, division engineer. A. B. Cohen was designing engineer.

Expanded Metal Bender Built on Construction Job

By P. Beall*

The accompanying drawing and view illustrate a bender for rib metal reinforcement used in a recent building construction job. The floor was of concrete incased I-beams with the 6-in. slab reinforced with No. 3 rib metal, 18 in. wide and 18 ft. long, bent 3 in. over the top of each I-beam, requiring 16 bends to each piece.

The body of the bender consisted of two 2x8-in. planks 8 ft. long separated by three 8x8-in. blocks 21 in. long and 4 ft. on centers, all well spiked together. The bender was made of an 8x8-in. crossblock 25 in. long, swinging on two 2x8-in. handles 11 ft. long and pivoted at the center of the middle block of the body on ¾-in. lag screws. The bender on the handle cleared the anvil on the body by ½ in., and the corners of the bender and anvil that did the shaping were protected with 1½x1½-in. angles. Over the anvil block on the body, where the shaping took place, an angle was set 1 in. off the top, so that the metal sheet could be slid under. This was held by ½-in. screws at each end, and one end was slotted so that it could be swung to one side

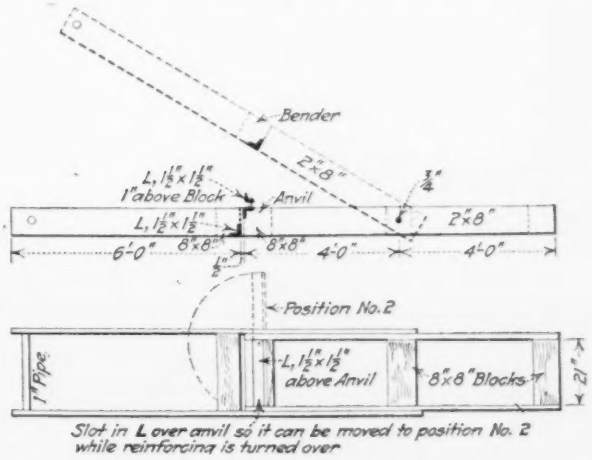


FIG. 2. DETAILS OF MACHINE FOR BENDING EXPANDED-METAL REINFORCEMENT

while the sheets of reinforcing were being turned over. The bender was built 3 ft. off the ground on a frame for convenience of operation, and another frame was built from which the handle could be raised by block and fall.

In operation the momentum of the block falling 2 ft. was sufficient to bend sheets, the number of blows depending on the angle of bend wanted. On account of the 16 bends it was necessary to turn each piece over eight times. After the gang was organized, the average cost of bending per sheet was 12c.

*223 West 78th St., New York City.

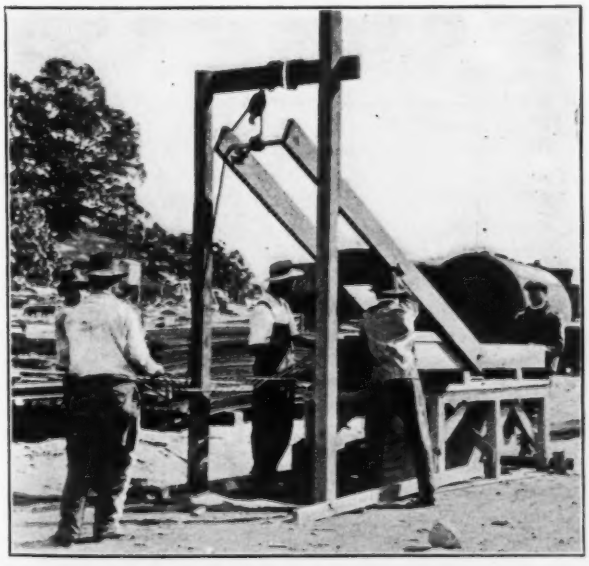


FIG. 1. METAL BENDER IN OPERATION

Oiling Rails and Fastenings To Prevent Corrosion

The corrosion of rails and fastenings due to the brine dripping from refrigerator cars has been an increasing trouble for some years, and although the Master Car Builders' Association has taken some steps to check this dripping the condition still continues. The damage and destruction to track by such corrosion as well as by that due to weather conditions is an important item in track-maintenance cost and is especially serious where high-priced materials and devices are used in the track.

About three years ago A. J. Neafie, Principal Assistant Engineer of the Delaware, Lackawanna & Western R.R., undertook to meet this problem of protecting the track by spraying oil upon the rails and fastenings. Experi-

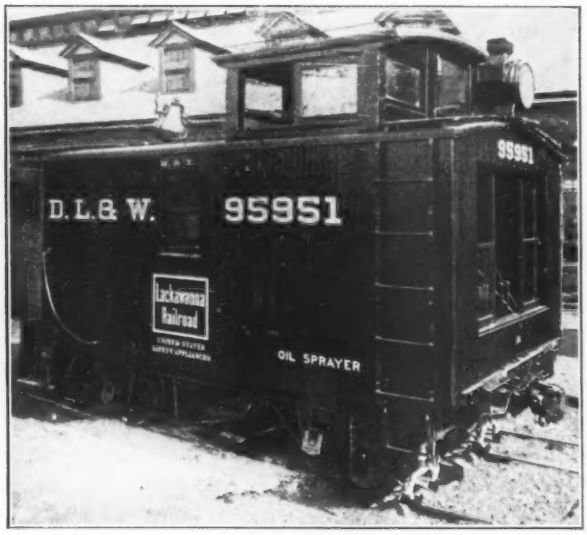


FIG. 1. CAR FOR SPRAYING OIL ON RAILS AND TRACK FASTENINGS

ments were made with hand-operated apparatus mounted on a flat-car, and the results were so satisfactory that a special car has been built for this service.

The track-oiling car resembles a four-wheel caboose and has the front end open for the observation of the operator, who controls the oil feed and the raising and lowering of the spraying apparatus by means of a series of air valves. In front of each forward wheel is a forked pipe with ends bent so as to discharge a spray against either side of the rails and joints and down upon the spikes and the plates. A shield covers the top of the rail head, and behind each wheel is a wiper or pad (to clean the rail head) and a sand pipe. The car is coupled at the head of a train of oil tank-cars (or a single tank-car), and the train is pushed by a locomotive, the oiling car being fitted with a bell and signal whistle. The work is done at a speed of 20 to 30 mi. per hr., using 100 to 125 gal. per mi.

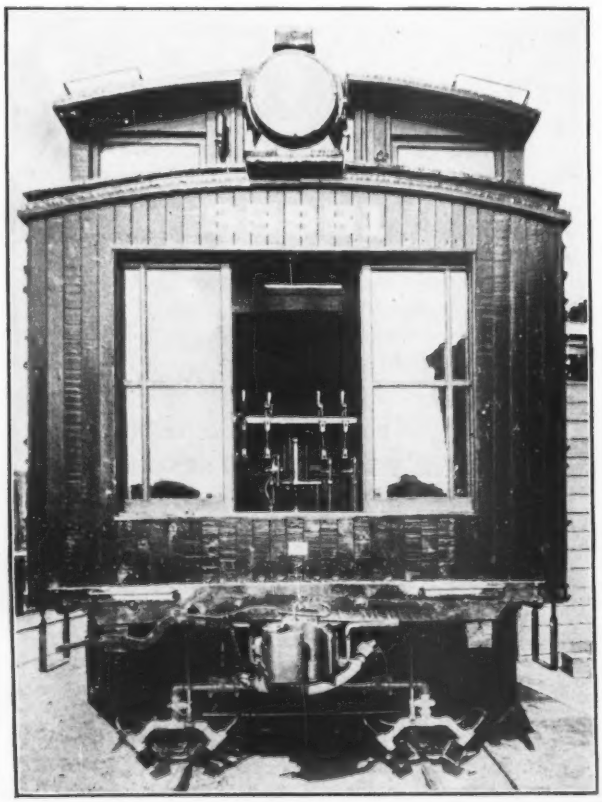


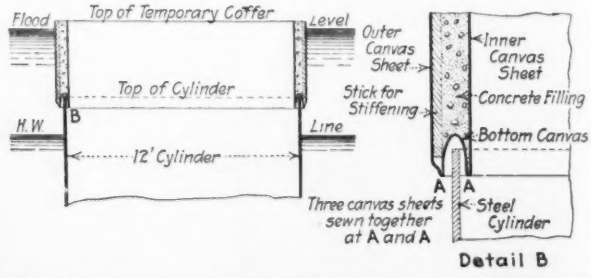
FIG. 2. FRONT OF OIL-SPRAYER CAR, SHOWING NOZZLES AND CONTROL LEVERS

The oil pipe is 2 in. in diameter, and ½-in. air pipes are led from a receiver to the nozzles, with a pressure of 30 to 40 lb. for spraying the oil. A 2-in. pipe connects the outlets of the tank-cars, this being laid along the frames or running boards. A ½-in. air pipe is led along the train and tapped into the dome of each car, to furnish pressure (30 to 40 lb.) for forcing out the oil. Live steam or the exhaust steam from the air pump is led to the heater coils in the tanks, giving the oil a temperature of about 150°. Valves provide for connecting or cutting out any oil-car as desired. A heavy oil is used for its adhesive properties.

About 800 mi. of track was oiled in this way in October, 1915 (with the hand-operated apparatus), and the new car oiled about 950 mi. of track during October, 1916. The cost for oil, operator, engine and crew, etc., is about $4 per mi. Mr. Neafie, who has furnished the information as to this interesting feature of trackwork, states that the results are beyond the original expectations.

Emergency Canvas Coffer-Dam

An emergency coffer-dam of canvas and concrete was an interesting feature in the construction of a 92-ft. Strauss bascule bridge over the inland-waterway canal at Coinjack, N. C., for the United States Government. The piers were 12-ft. steel cylinders, having their tops 2 ft. above the normal high-water line. During the floods of the spring of 1915 the water rose nearly 3 ft. above this



EMERGENCY COFFER-DAM OF CANVAS AND CONCRETE ON A BRIDGE PIER

level; and as it continued for some time, the work was seriously interrupted.

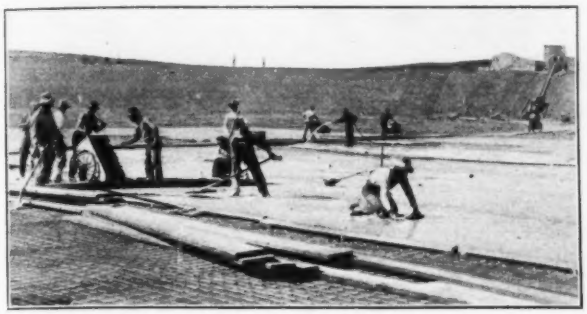
In order to carry the cylinder temporarily above flood level, two sheets of canvas were put together to form an annular chamber 3 ft. high and about 6 in. wide, the bottom being closed by a strip of canvas wide enough to extend up between the side sheets, forming an inverted trough. Vertical sticks were set in the outer leg thus formed, to keep the canvas in shape. Then the canvas cylinder was sunk to rest on the top of the steel cylinder. When the canvas was wet, it shrank so that the "trough" closed up and gripped the top of the steel. The space between the canvas sheets was then filled with concrete.

After the concrete had set, the interior of the cylinder was pumped out, and the work of filling it with concrete was commenced. There was no leakage at the connection of the permanent and temporary cylinders.

The bridge was built by the Penn Bridge Co., of Beaver Falls, Penn., and the emergency work described was devised by W. J. Howard, superintendent in charge.

Concrete-Lined Oil Reservoir

An earth reservoir with 3-in. concrete lining has been built by Bent Bros. at El Segundo, Calif., for the Standard Oil Co. This reservoir, which will be used for oil storage, is 460.5 ft. in diameter at the top and 403 ft. at



LAYING CONCRETE FLOOR OF OIL-STORAGE RESERVOIR AT EL SEGUNDO, CALIF.

the bottom, the width of the bank at the top being 15 ft. Both slopes are 1½ to 1. The total depth is 19 ft. 2 in. The reservoir is built in sandy loam formation, and during the construction the banks were sprinkled and rolled until they were solid.

The accompanying view shows the floor under construction. This is 4 in. thick and reinforced as shown. The capacity of the reservoir is 550,000 bbl.

Experience of 41 Railways in Small Concrete Jobs

The economical handling of concrete on work not exceeding 200 cu.yd. in volume was the subject of an investigation by a committee of the American Bridge and Building Association during the past year. The committee members are L. D. Hadwen, J. W. Wood, C. F. Green and G. H. Stewart. Information was obtained from 41 railways, having a total mileage of 127,500. A summary of these replies shows that 31 railways, representing a mileage of 100,280, handled their small concrete work with their own forces, while only two of the roads, having a mileage of 2,839, handled such work exclusively by contract. The question of safety and a desire to have the company's own employees handle construction under operated track or in the yards and shops have an important influence in eliminating contract work.

In regard to organization, 25 of the railways employ division forces, while 11 report a departmental organization. The supervision is generally furnished by master carpenters or division superintendents of bridges and buildings, and in some instances by the assistant engineers of the engineering department.

The rates paid, of course, vary largely according to the section of the country, the rate for laborers running from 13½ to 25c. an hour; for carpenters, from 21 to 35c., while foremen are paid from $90 to $100 a month. The size of the gang varies from six to twelve men, with one or two carpenters and a foreman. It is difficult to get adequate carpenter help on work of this kind, and a larger proportion of carpenters in a crew would promote the economy of the work, could they be obtained.

Of the 41 roads, 31 indicate that they are able to organize the work so as to admit of a regular program through the season, while five are unable to do this. Three handle work of this kind by means of regular floating gangs. In most cases a program is mapped out in the spring, and forces are organized to cover the season's work. A good way of taking care of such small jobs would be to have a crew organized under the district authority to take care of the work on each district or division, where the volume of work makes this justifiable. Some roads keep a regular gang all the year handling this class of work and moving from one division to another. A feature called attention to by the Nashville, Chattanooga & St. Louis Ry. is the use of suitable boarding cars for the crews. In the matter of providing material there is considerable divergence in practice. Local aggregate is used by 23 roads wherever possible. Generally, material for structures on the line appears to be handled by way freights. Where crews can be combined and material ordered sufficient for a day's work-train service, it is preferable to handle the material for three or four jobs rather than handle it by regular train with a small force.

Average Cost and the Tools Required

The cost of this class of work varies with conditions. Prices were quoted of $5 to $8 per yd. for mass work and $7 to $20 for reinforced work. As to a list of tools considered essential for a small concrete outfit, the following, submitted by the Chicago, Milwaukee & St. Paul, is regarded as typical:

1 Concrete mixer	3 Tubular lanterns
10' Wheelbarrows	1 Single bit axe
1 Cant hook	2 Water barrels
50 Ft. 1-in. water hose	6 Heavy galvanized water pails
1 Small track-jack	1 Gasoline diaphragm pump
1 Combination vise	1 Pinch bar
1 Hand axe	2 Combination nail pullers
1 Double bit axe	1 Measuring box
1 Sheetpile pounder	1 Tool box
1 Timber bar	1 Steel broom
1 Crosscut saw	3 Common brooms
1 No. 4 sand screen	1 Stone-mason trowel
12 D. H. S. P. No. 2 shovels	1 16-ft. straight-edge
6 Pairs knee boots	1 Plasterer's trowel
1 D. H. spade	2 Pairs wire pliers
1 8-lb. sledge	200 Ft. 1-in. line
1 16-lb. sledge	6 Track chisels
1 8-ft. straight-edge	2 12-in. monkey wrenches
1 Grindstone and frame	2 18-in. pipe wrenches
4 Clawhammers	1 Set 8-in. double blocks for 1-in. line
4 Pairs carrying hooks	
2 Heavy mortar hoes	
2 ⅞-in. bridge augers	

In most cases the carpenters are required to furnish their own tools, but it is economy to have a liberal supply of hammers, saws, etc., on hand, so that laborers can be pressed into service for sheathing the forms, etc., when they would otherwise be waiting. For crews making frequent moves a tool car is worth having.

The size of mixer recommended shows considerable variation. Only six railways stated a preference for hand mixing for small work; 16 recommend mixers of from 6 to 9 cu.ft. capacity, unmixed charge, which corresponds to a one-bag batch mixer. A ½-yd. or two-bag batch mixer is preferred by eight roads, while two use ¾-yd. machines.

Opinions as to the smallest job on which the use of a mixer is justifiable vary widely. Four roads use some form of mixer for quantities as small as 5 yd.; six would use one where the quantities are from 10 to 30 yd.; five set 50 yd. and six 100 yd. as a minimum.

Building Culvert for 150-Ft. Fill

A 5-ft. concrete arch culvert 533 ft. long is being completed on the Southern relocation in Georgia, just south of Toccoa. The unusual length of the culvert is explained by the fact that the fill will be 150 ft. high by 530 ft. wide at the base. The culvert is built almost (85°) at right angles to the center line of the fill. The wall is 4 ft. thick at the floor and 2 ft. 10½ in. at 1 ft. above springline. The concrete above springline is 1:2:4; below springline, 1:2½:5. Granite screenings

For the greater part of its length, including that portion under the deepest part of the fill, the culvert is on rock, which occurs near the surface. For about 200 ft. on the west end, however, the rock dips, and piling is resorted to. Two lines of piles, staggered, are driven under each side of the arch. The soil is earth and soft rock. The piledriver at the extreme right in Fig. 1 was built on the job and is equipped with an 1,800-lb. Vulcan hammer. A boiler was part of the equipment, but instead of mounting this on the platform of the driver, steam was piped from the horizontal Farquhar boiler shown near-by. Unencumbered and unweighted by a boiler, the piledriver is much more easily portable.

The concreting plant should be examined in connection with Fig. 1. A ¼-yd. Lakewood mixer is mounted on timber cribbing about 8 ft. high, with a platform or walkway extending out over the forms. Concrete is

FIG. 1. GENERAL VIEW OF CONCRETING PLANT AND WEST END OF CULVERT SITE

FIG. 2. NEAR VIEW OF MATERIALS DEPOT SHOWN IN BACKGROUND OF FIG. 1

are used instead of sand. In the early part of the work the contractor, C. W. Lane & Co., was not permitted to use granite screenings, but following tests which showed concrete containing them to be stronger than concrete with sand, these screenings were used exclusively. In addition the concrete flows better, that there is less separation and that it retains the water better than does concrete containing sand.

transported from mixer to form in ⅛-yd. two-wheel skips pushed by men.

Concrete materials are delivered on the track shown in the background of Fig. 1 and at close range in Fig. 2. The stone and screenings are dumped down the embankment; the concrete is stored in the house built for the purpose. The materials are hauled in wagons to the piles behind the mixer.

Engineering Contractor Talks on Earth Shrinkage

By S. P. Baird*

Writers of books are as prone to copy the mistakes of other authors as they are to copy the matter that will stand test—giving due credit, of course. I have been reading several books on engineering subjects, especially the chapters given to earthwork and more particularly the paragraphs devoted to the change in volume when

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earth is disturbed. The information generally conveyed to the reader is that earth will shrink when moved from a cut to a fill; in other words, a yard of cut will *not* make a yard of fill.

Observation convinces me that there is an *apparent* shrinkage in volume; but I am also convinced that it is not necessarily a shrinkage of the earth making the fill, but rather a combination of the following factors: (1) Settlement of the original ground on which the fill is made; (2) that the actual yardage removed from the cut is less than the calculated quantity; (3) the actual yardage in the fill is more than it was calculated to be.

Regarding the settlement of the original ground under the added weight of the fill, I can call to mind a number of instances where drain pipes under the center of heavy fills settled until they have become inverted siphons. In an extreme case, while making a fill by dumping from a trestle, the fill, trestle and train settled 16 ft. in a very few minutes. The total settlement at this place was more than 200 ft.

Another case that I have in mind, showing the settlement of the ground under the weight of the fill, was very forcibly called to my attention during the construction of an undercrossing through a heavy fill. The original surface was well defined by the grass line between the original earth and the filled material. This line showed a gradual settlement increasing toward the center of the fill. The original field notes showing the ground line at the point at which the undercrossing was being constructed were available and showed no such depression.

One more instance to indicate that the settlement of the original ground is not an infrequent factor in the apparent shrinkage of excavated earth: A railroad crossed a creek and valley on a timber trestle about 20 ft. high. It was decided to fill most of the trestle, spanning the main stream with a deep plate-girder span on steel legs on low masonry piers, with a short girder span at each end resting on masonry abutments. The piers and abutments were constructed and the steelwork was erected before the filling of the trestle began by dumping from trains. The earth-fill had not reached the bottom of the stringers before it was noticed that the trestle had settled very noticeably (about 2 ft. where the fill was highest), except near the abutment. The driving of the piling under the abutment probably packed the ground by side pressure. The remainder of the fill was made with ashes, and the track was jacked to its original height. When the stringers were removed, it was found that the total settlement amounted to 3½ ft. It has been my experience that comparatively shallow fills on an unyielding bottom can be made from cuts having the same yardage. The lower portion of heavier fills will be somewhat compressed by the weight of the earth above, but not to the density of the original earth.

Shrinkage Tests with Cellar Spoil

Carefully made cellar excavations are capable of quite accurate yardage measurements. On one occasion all the earth from the cellar was weighed and then dumped on a lot for filling. The surface of the lot was flat and the fill was about half the depth of the cellar. The volume of this fill was about 14% greater than the cellar excavation. At the end of a year it was 10% greater.

While the cellar was being excavated, a number of tests were run by filling a stout box, 3x3x3 ft., with freshly excavated material and tamping in layers; the box of earth was then weighed. It was found that the weight, approximated the weight of a yard of the original material.

Another experiment was tried. The box was filled with loose earth, and a loosely fitting piston was placed on the material in the box and weighted with pig iron to give a pressure equivalent to a 20-ft. fill of earth. Two weeks' compression brought the earth in the box to about the same density as the original earth. Of course, in this test there was side friction, which would not occur in an open fill.

Contractors Do Not Boast About Profits

The general run of contractors never admit that they are making any money, but rather give the impression that they are losing. It is but human for the rodman, the instrumentman and the tapeman to give them the benefit of the doubt, as it is very unlikely that there will be a remeasurement on account of the quantities being too large. In cross-sectioning muddy or soft ground it is easy to get readings a couple of tenths low, on account of the rod sinking in the mud. Fills are more likely to be on this kind of ground than cuts. I have remeasured several pieces of work and never have found much difference that could not be accounted for by the weathering of the cuts, difference of the viewpoint and difference in the time of the year as affecting the shadows and as affecting the height of the surface due to freezing (quite a factor in shallow work). This latter tends to reduce the yardage of cuts and fills alike by raising all the rods from 0 $\frac{1}{10}$ to $\frac{3}{10}$ ft., according to the material. The weathering erodes narrow grooves down the slopes. These grooves are not measurable, but owing to their length and multiplicity they raise the bottom of the cuts by filling in with the eroded material. This gives too small a quantity on remeasurement.

Ground-line elevations taken on grass, forest and plowed land will invariably be a couple of tenths above the solid earth. These tend to increase the apparent cut yardage and to decrease the apparent fill yardage.

As for the fill yardage being more than calculated, the method of making fills causes the edges of the fill to overrun the slope stakes, as clods will roll down the slopes and out on the original ground, increasing by just that much the apparent yardage of the fill. Engineers generally insist on measuring borrowed material in the borrowpits rather than in the fill, knowing that there is less material in the solid earth than in the fill that it will make.

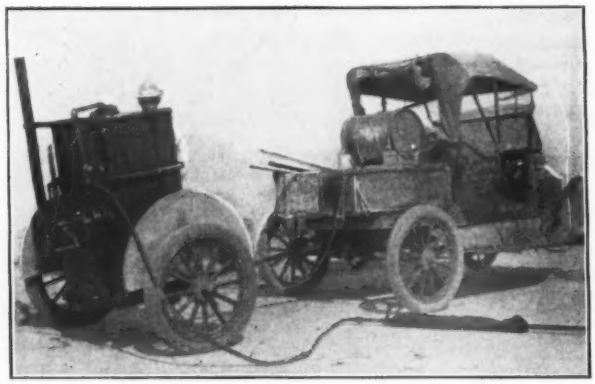
Asphalt-Joint Filling Machine

By J. S. Bright*

Difficulty in making a bituminous carpet stick over the expansion joints on the 87 mi. of recently constructed concrete pavement in San Bernardino County, California, led to the invention of a special joint-filling machine. It has proved a success in use.

The pavements are of 1:2:4 concrete, 5 in. thick, and are finished with a wearing surface or carpet of asphaltic oil and screenings. Expansion joints of the Carey sandwich type were provided at intervals of from 30 to 75 ft., depending on the season and relative humidity at

*Engineer, County Highway Commission, San Bernardino County, San Bernardino, Calif.



JOINT-FILLING MACHINE, SAN BERNARDINO COUNTY, CALIFORNIA

the time of placing the concrete. Generally, expansion followed the uncovering of the pavement after construction, forcing the joint filler nearly all out. The ejected asphalt was ironed out into a mat over the joint, which did not adhere to the concrete, and as a result formed a weak spot under the asphalt carpet coat that was afterward applied, so that it would not remain over these places.

To remedy these defects it was found necessary to dig out the joints to a depth of ½ in., clean the adjoining pavement and refill the joint with 90% asphaltic oil, heated to a temperature of over 200° F. To do this economically it was necessary to have a machine different from any on the local market.

After experimenting and making several changes, the machine shown was perfected. This device consists of a 100-gal. drum mounted on a pair of Ford automobile wheels. Beneath the drum is a firebox containing four distillate burners. These burners are supplied from a small drum carried on the front vehicle and connected to the burners by a flexible hose.

The hot asphaltic oil is drawn from the drum and sprayed through a chisel-shaped nozzle by a hand-power rotary pump. A bypass connects the discharge line with the top of the drum so that the oil can be circulated when the machine is not in use, to prevent the pump and lines from cooling and clogging.

The burners are generally kept burning low at night to prevent the oil from cooling, as it takes about three hours to reach a sufficient temperature to spray. It is usually necessary to clean the pump and discharge line either at night or in the morning with distillate.

The oiler is filled at a central heating plant and is towed to the work or filled from 5-gal. buckets distributed along the road. The heavy asphaltic oil in the buckets must be heated before it can be emptied into the drum.

The thickness of the coat of oil applied can be regulated by the rate of rotations of the pump and by a valve in the discharge line under the control of the nozzleman. It is surprising how thin a coat can be applied by this machine, but the oil has to be at a temperature of 300° F. to obtain the best results.

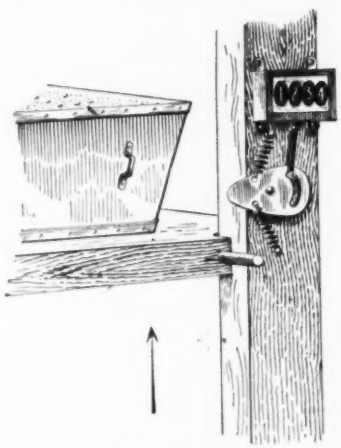
The crew ordinarily consists of a foreman, pumpman, nozzleman, one man to shovel screenings, one man to sweep, two men to pick out the joints, and teamster and team hauling about 2 cu.yd. of crushed-rock screenings and towing the oiler. This crew has finished joints on 48 mi. of road in one month at a cost of about $10 per mi. The oil and screenings had to be hauled from 5 to 35 mi. The outfit can cover from 1 to 5 mi. of road per day, depending upon its condition.

To protect the refilled joints prior to the application of the wearing surface it is necessary to use a surplus of oil in filling them. In order to avoid a bump, after the wearing surface is applied the surplus of oil at the joint is removed, which is best done by using a hot spade or a mattock just in advance of the application of the wearing surface.

FINE AGGREGATE

To Erect a Large Factory Building in 42 Days is the schedule set down in a bulletin just received from the Aberthaw Construction Co., of Boston. The building which is to be erected for Colt's Patent Fire Arms Manufacturing Co., at Hartford, Conn., will be 490x60 ft. in plan, with two end wings. It will be four stories high and have a floor area of 2.8 acres. On Oct. 6 the superstructure was begun; the second floor was to have been concreted by Oct. 21, and by Nov. 2 the third floor is to be completely concreted; on Nov. 13 the fourth floor, and on Nov. 23 the roof.

Automatic Counter for Concrete Elevator—In the construction of a reinforced-concrete building at Philadelphia it was desired to count the number of buckets of concrete delivered to each floor. These buckets were delivered on the regular timber-frame elevators with platforms carrying one bucket of standard size, so that to check the amount of concrete it was merely necessary to check the number of times the elevator went up by each floor. To do this an ordinary dial counter was attached to one of the posts of each elevator, as shown in the accompanying perspective. The dial was actuated by a link tripped by a cam that was pinned to the elevator post. In going up, the pin driven firmly into the elevator platform tripped the cam and depressed the link, thus marking the counter. In going down, the same pin also tripped the cam; but a slot was placed in the rear end of the cam so that the link did not actuate the counter, but traveled along freely in the slot. The cam was pulled back to its proper balance by coil springs attached above and below. The device is reported by W. A. Tailer, of 3634 North 12th St., Philadelphia, Penn.



Anchoring a Submarine Water Main was recently done in a rather novel manner by the operating bureau of the San Diego, Calif., Water Department, F. M. Lockwood, manager. A 10-in. main 665 ft. long was laid across the San Diego River at a cost of $1,902.18. This main was buried 2 ft. below the bed of the river, and at each joint two 60-lb. rails were driven full length (30 ft.) into the ground and clamped to the pipe, both above and below, making it practically impossible for the pipe to rise up or become displaced.

Problem of Interest Rates in Loan Repayment—A complicated problem is submitted by A. F., Ottawa, involving calculations of the sinking-fund type. It is stated as follows:

A city makes a loan for $1,000,000, to be paid in 12 years in installments of $120,000 yearly, the first payment being made 6½ months after contracting the loan. What will be the annual rate of interest on the loan?

Starting with the fact that the accumulated value of the loan after the period of 11 years 6½ months must be equal to the accumulated value of the repayment, the following equation is obtained:

$$1{,}000{,}000\,(1+i)^{11\frac{6}{12}} = 120{,}000\,\frac{(1+i)^{12}-1}{(1+i)-1} = 120{,}000\,\frac{(1+i)^{12}-1}{i}$$

Some reader may be able to suggest how this can be solved other than by trial, or give a direct methed for solving the problem.

Editorials

A School for Training Executive Officers

One of the most notable developments of the past 20 years in industrial education has been the rapid increase in the establishment of training courses for employees. The pioneers in this field were probably the railway companies which established schools for training employees in the use of air brakes and the operation of signaling systems. In the manufacturing industry, while training courses for apprentices are of course very old, schools for training men and women of mature years in specific tasks are comparatively recent.

One of the largest concerns in the iron and steel trade, acting on the belief that its high-salaried executive officers may be as much benefited by training as the ordinary employee who is tending a machine, has established a school for training executives. The students in this school are from 40 to 60 years of age, and the average age is 52. The head of the school is a Cornell graduate of the class of 1892. The course of instruction includes shop practice, administration and theory. The course of instruction extends over six weeks, during which time the students give their entire time to the school work. Their salaries continue as usual during this time, and their traveling expense in visiting different works of the company during the course are paid. The cost of the school apart from these items is about $35,000 per annum. The usual routine is to spend a forenoon in the shop and the afternoon in attending lectures, while the evening is devoted to the study of textbooks. The students are given examinations at stated intervals, and their markings in the examinations are sent to the head office of the company.

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Divided Authority Produces Bad Results

Divided authority is divided responsibility, which often is the same as no responsibility. Unless engineering responsibility is centralized, in the design and erection of a structure, the structure may prove a failure.

A case of this kind is pictured in the statement of facts about a recent reservoir break. As the statement comes from an engineer familiar with local conditions, it should be fairly accurate.

The reservoir that later failed was built under the direction of the Water Department. But the Water Department did not design the reservoir. Instead, it secured a design from a civil-engineering professor of high standing. The authority of the designer ended with the design. He had nothing to do with the execution, this being in the hands of a contractor employed and directed by the Water Department.

Responsibility being thus already divided, the case was further complicated by the fact that a large part of the work was built without any engineering inspection. An inspector appeared on the work when the side walls of the reservoir were nearing the roof. This was an important period, because the construction work had to insure that the roof would be tied to the walls very thoroughly. The design intended the walls to act as vertical beams held at floor and roof, but did not provide means that would positively assure the necessary anchoring.

The results show that even the belated presence of an inspector on the work did not secure a proper tying of the walls to the roof; but as the inspector was inexperienced, he ought not to be blamed, perhaps.

The reservoir so constructed was successfully filled with water and used for half a dozen years. Earth banked up around the outside of the reservoir held the walls against the outward pressure of the water. Recently, however, work was started on an extension directly alongside.

A firm of consulting engineers was placed in full charge of this work, and thereby part of the responsibility for the old structure fell to them, for the time being. They specified that the contractor should brace the old wall. But the contractor says that he found nothing handy against which to brace the wall, and therefore he did not brace it. He took the chance of digging away the embankment and hurrying the work sufficiently to get the new wall in before the old one could fail. In this he did not succeed.

The responsibility for the final failure is thus distributed over a whole group of individuals. As the facts show, what was everybody's business was nobody's business; and the public, which trusted to the engineers for a safe reservoir, found itself deceived.

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Locomotive-Flange Oiling To Save Rail Wear on Curves

A committee report presented at the recent annual meeting of the Traveling Engineers' Association calls renewed attention to the advantages of flange oiling of locomotive driving wheels in saving rail wear. The committee states that on the New York, Susquehanna & Western Division of the Erie R.R. the rail wear on curves has been reduced two-thirds by the use of flange oilers on the locomotives. The committee also believes it to be fully demonstrated that the flange oiler tends to prevent derailments. A number of railways reported that before applying flange oilers they had considerable trouble with wheels climbing the rails on sharp curves, but this trouble has been eliminated since flange oilers have been applied.

For success in the use of the flange oiler a very heavy asphaltum oil must be used. The oil should contain 40 to 60% of asphaltum in solution and be low in grease and paraffin. This heavy oil acts as a lubricant between the wheel flange and the head of the rail when a lighter oil would be forced out. Further than this, the heavy asphaltum oil sticks to the flange and will not work over onto the tread of the driving wheel, as will an oil with a paraffin base. Many of the troubles that have been

experienced with flange oilers are due to the use of oil that runs over onto the tread and causes the driving wheel to slip.

From an operating point of view, the saving in tire turning is even more important than the saving in rail wear. The committee estimates that the cost of tire metal used up, labor and loss of engine service every time a six-driver locomotive has to go to the shop for turning tires on account of sharp flanges represents an outlay of $219. The committee also states that where freight locomotives not equipped with flange oilers will run 9,000 to 12,000 mi. before requiring shopping to have their tires turned, they will run between 25,000 and 42,000 before shopping if equipped with flange oilers. In passenger service, locomotives that have to be shopped every 15,000 to 25,000 mi. should run 60,000 to 80,000 mi. if equipped with flange oilers.

Notwithstanding these practical advantages, the flange oiler appears to have as yet comparatively limited use. The reason apparently is inertia on the part of the operating force and dislike to equip locomotives with any appliances not absolutely necessary. It is inertia of this sort, however, that is responsible for a great deal of the unnecessary expense in connection with large-scale operations, whether carried on by corporations or by the Government.

Allowances for Obsolescence in Making Appraisals

The contribution of C. C. Harshman on obsolescence, elsewhere in this issue, serves to call attention to one feature of the work of appraisal that has been too much neglected by engineers. Doubtless this neglect is unconscious. Most engineers would claim that they had made full allowance for obsolescence in figuring depreciation, but when two items of a different sort are lumped together in an appraisal there is always a likelihood that one or the other may not receive sufficient attention. The main advantage of making a separate item of obsolescence is that there is greater certainty of this element receiving thorough and careful study.

One of the reasons why obsolescence is often neglected in making estimates is that a tool or machine may continue in use year after year with apparently no loss from obsolescence and then suddenly, by some new development, become out of date. A few months ago, a member of the staff of this journal visited a small pumping plant in southern California, used to raise underflow water for irrigation. The plant was built within the past ten years. A pair of horizontal return-tubular boilers furnished steam to a duplex direct-acting pumping engine with necessary auxiliaries for boiler feeding, fuel handling, etc. The machinery was erected on substantial foundations and housed in a permanent fireproof building. The plant was well designed and economical in operation; and as it was used only for a short time during each year, the physical depreciation had been practically nil. Since this plant was built, the electric motor-driven centrifugal pump had been made a commercial success. In one corner of the station stood a centrifugal motor-driven pump occupying not a twentieth part of the floor space of the steam plant and involving a trifling expense for maintenance and operation compared with its rival. At one stroke the practically new steam plant had had its value reduced to scrap. This instance is merely typical of the sudden losses of value that may be expected to occur sooner or later with almost all mechanical equipment as a result of the steady progress of invention and design.

No engineer is wise enough to foresee when a given machine that is now the best of its class and perfectly adapted to its work will be rendered obsolete by some new invention. The engineer knows, however, that the *liability* to such a loss occurring is always present, just as there is a certain liability that any plant will be destroyed by fire. Why is it not then as reasonable to make an annual charge for the risk of loss by obsolescence as it is to make an annual charge for the risk of loss by fire? The payments made for fire insurance are a part of the annual operating expenses; and even where a concern does not carry insurance, the risk due to loss by fire should be charged just the same. Exactly the same rule should be applied in making a charge for the risk of obsolescence destroying the value of the machinery in which the company has invested its money. Unless this is done by a public-utility corporation, it may eventually have to suffer serious losses that should in equity be borne by those who have the benefit of its service. The present obstacle to adequate treatment of obsolescence is the lack of accumulated experience as a guide.

Grade-Crossing Dangers Are For the Foolhardy

"The deadly grade crossing," according to statistics recently made public by the Pennsylvania Railroad Co. is chiefly dangerous to those who are guilty of foolhardy recklessness. Safety gates at crossings are provided to prevent the traveling public from crossing the tracks when a train is approaching; but the Long Island R.R., which has numerous grade crossings subjected to heavy automobile traffic, finds its safety gates continually broken down by motor cars running too fast to be stopped before striking the gates.

This is bad enough, but what shall be said of the man who runs his motor car into the side of a moving train? The Pennsylvania R.R. officials state that during the first eight months of the present year, drivers of 23 motor cars ran their machines into sides of trains, that were part way over the crossings. Besides these vehicles, six motorcycles, two bicycles and four horse-drawn vehicles were driven into the sides of trains. The accidents caused in this way resulted in the deaths of six persons and the injury of 65.

It is sometimes argued that because of the high speed at which present-day highway traffic is carried on, all grade crossings should be abolished. Great progress has indeed been made in this work in the past 20 years. The Pennsylvania R.R. alone, on its lines east of Pittsburgh, has expended $40,000,000 in grade-crossing removal since 1902. To abolish all grade crossings, however, in a country of the enormous extent of the United States is a work that will require the accumulated capital of generations to accomplish. Meanwhile, it will be well to remember that the grade crossing is only one point on the highway where danger confronts the reckless motorist. To the man who uses reasonable care in his driving, the danger element in the grade crossing is trifling.

Letters to the Editor

Sense or Sentiment To Govern in Sewage Treatment?

Sir—In the course of the discussion on activated sludge at the recent convention of the American Society of Municipal Improvements, F. A. Dallyn, provincial sanitary engineer, Toronto, Ont., made the statement that while methods of sewage purification could be depended upon to give an effluent from 95% to 98% pure from a pathogenic standpoint, public sentiment in Ontario was demanding an effluent whose pathogenicity was zero, principally because cattle make use of the streams below the point where the purified sewage is discharged.

He admitted that typhoid could not be transmitted because of cattle drinking such waters, but stated that it could be transmitted by reason of the unsanitary practice and carelessness in milking cows whose udders had been wet by water in rivers into which treated sewage 95% to 98% pure had been discharged. This unclean practice, he stated, consisted in wiping off the udders with a dirty cloth or washing the udders with dirty hands, using the milk for washing.

In view of the fact that no sewage-disposal plant can under present conditions be guaranteed to yield an effluent at all times even approximating 95% to 98% pure pathogenically, and in view of the further fact that the only need of such an effluent is to enable us to tolerate the unsanitary practice and carelessness in dairies pointed out by Mr. Dallyn, can the engineering profession afford to permit the public to believe that its safety lies in a futile effort to prevent the very remote possibility of typhoid contagion due to contact of the udders with water in streams receiving treated sewage? Does it not rather lie in the insistence upon drastic regulations requiring cleanliness in dairies, where, along with the care against the remote possibility of typhoid infection from the cause stated, we can prevent the direct entry of the dirt and filth through which the milk must run the gantlet?

Why permit the setting up of impractical and impossible standards, the failure to attain which will bring disrepute to the engineers, when better results can be obtained in a more simple and positive manner, and more economically withal? ALEXANDER POTTER.

50 Church St., New York City, Oct. 16, 1916.

Canadian Engineers and Alien Appointments

Sir—Referring to your editorial under the caption "Canadian Engineers Object to Appointment of Aliens," published in *Engineering News* of Oct. 12, 1916, I have spoken with quite a few prominent engineers on this subject, and they are unanimously of the opinion that you struck the nail on the head when you said: "Any organization of engineers should beware of placing itself before the public as seeking to claim appointments for its members. There could be no surer way of forfeiting public confidence and respect."

If the arguments and statements made by "J.G.S." and published in *Engineering News*, page 180, Vol. 51, issue of Feb. 25, 1904, were true, it would appear that the students of 1904 have advanced to the control of the Canadian Society of Civil Engineers in 1916.

Winnipeg, Man., Oct. 21, 1916. J. G. SULLIVAN.

[In the letter referred to by our correspondent, published in *Engineering News* 12 years ago, it was denied that the members of the Canadian Society of Civil Engineers were by any means unanimous in favoring legislation to give members of that society a monopoly of the engineering work in Canada. The writer said:

> I am proud to be able to say that not a single engineer voiced approval of the idea, and the cheering was apparently done by the land surveyors and some of the younger members of the society, who constituted the majority of those present at the dinner.

The letter presented reasons why the engineering profession would make a mistake if it adopted labor-union methods to promote its interests—Editor.]

A Fishy Sewage-Treatment Scheme

Sir—By hearsay, I have come across the following story. It may or may not be true, but will serve as an illustration of the need of expert advice for laymen when they consider matters of a nature foreign to their own business.

A large tannery in one of the Eastern States is located on a fresh-water stream that is small enough for one to jump across. The wastes from the tannery have been allowed to flow into the stream for some time. Recently the State Board of Health has protested, and the owners of the tannery have expressed their willingness to spend money on a treatment plant if some method can be devised to properly treat the wastes. Shortly after this the State Fisheries Commission began demanding the cessation, at once, of the practice of putting the wastes into the stream. It contended that all fish would be killed. No doubt this was true; probably all fish had been killed in that stream long ago. The owner of a patent on a device for treating tannery wastes then came to look over conditions. He stated that by installing his process the regulations of the State Boards of Health and Fisheries could be observed and all difficulties be eliminated.

It seems that the device contemplates holding the wastes in a tank for 90 days, and the cost for the installation to treat the wastes for the one tannery would be over $100,000.

The owners have objected to any such proposition but are being backed into a defensive attitude by the insistent demands of the Fisheries Commission.

The fact that makes the whole affair smell queerly—fishy, as it were—is that the gentleman who owns the patent on the process for treating tannery wastes is a State Fisheries Commissioner. OBSERVER.

Somewhere, Oct. 20, 1916.

Mechanical Agitation of Sewage Proved Unsuccessful

Sir—In your issue of Sept. 21 there appeared an editorial on drifting-sand filters. You suggested that some of the devices might be used in the activated-sludge process and called attention to the fact that some investigators, more particularly in England, had urged mechanical agitation as an economical substitute for enforced aëration. Probably the view that stirring with compressed air is inefficient has been taken because engineers are well aware that ordinarily considerable energy is lost in the transmission of power by compressed air, but a little thought will show that the loss is, to a great extent, avoided in enforced aëration.

When air is compressed, the energy input is absorbed in two forms. The air is put under tension, and it is heated. The heat is dissipated before the air is used, and hence this portion of the energy is lost. The loss manifests itself when the air is expanded to release its energy, as it then cools below normal temperature and occupies less volume than it otherwise would. This particular loss is eliminated when the air is used to stir a liquid whose temperature is approximately that of the free air. The heat is lost in transit just the same, but is reabsorbed from the liquid as the bubbles rise from the tank bottom.

Moreover, the expansion of the air is perfect, and it is rejected at the surface of the water with practically zero velocity. These favorable conditions are not exactly fulfilled by any other devices used for transforming into work the stored energy of compressed air.

The only losses in transmitting work from the prime mover to the liquid are the slip of the blower and the frictional losses in compressor and air lines, but these should not total over 25 to 30%. It would seem likely that losses in mechanical agitation would total higher. Unless the plant were very small indeed, a number of agitating units would have to be provided. These units would either have to be driven individually by small and hence comparatively inefficient motors or else by shafting and gearing, which would absorb power, particularly under the exacting conditions that would have to be met.

It is evident, therefore, that from the standpoint of merely transmitting power to the water the compressed air is fully as satisfactory as any mechanism would be. Undoubtedly, however, the nature of the agitation afforded in either case is somewhat dissimilar. The question then occurs as to whether the particular kind of agitation furnished mechanically might not be the more efficacious.

About a year ago the writer conducted at the Milwaukee testing station a series of experiments that were designed to throw light on this particular point. Sewage and sludge were agitated in a tank 22 in. square and 4 ft. deep by means of screw propellers and stirrers, of which a number of sizes and forms were tried out from time to time. The power input to these was brake tested and so regulated that it was equivalent to the power afforded by aërating the tank with about ⅓ cu.ft. of air per minute per square foot of tank surface, which had been found ample for complete clarification in 4 hr. Two sides of the tank were of glass, so that good visual observation of the stirring could be had.

The experiments showed that absolutely no clarification could be obtained by mechanical agitation even when it was prolonged to 24 hr. or more. If some air was added, clarification resulted; but the strength of the reaction seemed to be dependent entirely on the volume of air and to be independent of the amount of agitation. This would make it appear that the main factor in the process is absorption of oxygen and that agitation is only incidental or at least only a minor consideration. Additional evidence of this was obtained the following spring, when a practical way of finely subdividing the air was discovered. It was then found that, with well-activated sludge, clarification could be obtained by agitating with only ¼ cu.ft. of finely divided air to the gallon of sewage, which provided only one-sixth of the energy afforded when mechanical agitators were run 4 hr. and only one thirty-sixth of the total energy input when the 24-hr. run was made. Yet in the first case good clarification is secured and in the second none at all.

The writer does not want to be understood as saying that it is practical to operate an activated-sludge plant with only ¼ cu.ft. of air to the gallon. It distinctly is not practical to do so at the present time. It is a well-known fact that the amount of air used can be very materially reduced for a short time if the sludge is well activated, but the activity of the sludge is quickly lost if the practice is continued.

This, by the way, is additional evidence that agitation in itself plays a minor part, for it is difficult to conceive of the sludge as storing up energy when the agitation is violent and releasing it when it is less intense; but it is easy to see that the bacterial activity induced by liberal aëration would not be so quickly lost when the air supply was cut down.

Paradoxical as it may seem, it is only when aëration is proved to be all important and agitation incidental that mechanical stirring will prove economical. The reason is that the amount of agitation necessary to maintain the sludge in suspension and which, patently, cannot be dispensed with, can best be furnished by a mechanism, for the object will then be to move the water in streams near the tank bottom rather than to cause violent eddies and swirls, and it is probable that a stirring device would be best adapted to this end.

This combination of mechanical stirring plus aëration cannot of course be used at present, as the amounts of air required in practice are more than ample to stir the mixture, but will only come into use if some very much more efficient means of introducing the necessary oxygen are found.

CARL H. NORDELL.

Milwaukee, Wis., Oct. 9, 1916.

Defining the Right and Left Bank of a Stream

Sir—As a matter of information, I would like to know which is the right and which is the left hand bank of a stream; that is, whether you call it the right hand side when facing the source of the stream, or the right hand side when facing the mouth?

HERBERT HENDERSON,
Constructing Engineer, Gulf Refining Co.

Port Arthur, Tex., Oct. 7, 1916.

[The question that our correspondent raises was discussed at length in various issues of *Engineering News*,

Vol. 54, July-December, 1905. The information brought out at that time from numerous sources was that according to the rule laid down in the United States Manual of Land Surveying, the right and left banks of a stream are those on the right and left hand of an observer facing *down*stream. On the other hand, in the mountain districts of the South where old deeds refer to the right and left bank of a stream, it is almost invariably found that what is meant is the right and left bank when the observer is facing *up*stream. This latter rule also applies, according to the best information, to forks.—Editor.]

The Quebec Bridge Accident

Sir—Referring to the several communications in regard to the Quebec rocker stresses published in your issue of Oct. 19, and your editorial comments thereon, the final sentence in the latter: "The casting is in fact subjected to such a complex set of stresses—both direct and secondary—that analysis can only lay emphasis on the need for ultraconservative design in such a case," suggests that the following simple analysis indicates that, although the exact internal stresses cannot be determined, an indication of their character should not be ignored.

At either the top or the bottom of the casting we have the extreme fibers of one rib in compression with the extreme fibers of the other rib in tension at right angles to it. Resolving these stresses into their components with reference to a diagonal section, shown in diagram, it is seen that there will be a shearing stress on this diagonal section; and if the two ribs are of the same width and the tension stress equal to the compression stress, this shearing stress will be exactly the same in pounds per square inch as the tension or compression. As this shear is horizontal in direction and the edge of one of the ribs inclined, the other being horizontal, the complexity of the stress at this point is apparent; and in all probability the shearing value of the metal is more important than the tension value.

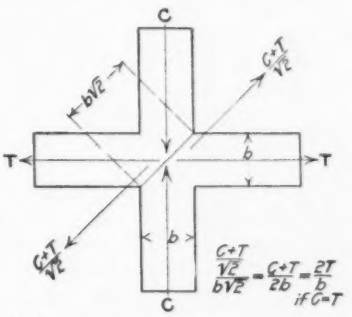
HOWARD C. BAIRD.

149 Broadway, New York, N. Y., Oct. 20, 1916.

Sir—Concerning the loss of the suspended span of the Quebec Bridge, on page 529 of the issue of Sept. 14, it was stated that "so long as the span remained absolutely level, and absolutely central on the lifting girder, there was no tendency to tip or rotate the girder. . . . As the truss shoe settled down through the broken fragments of the casting, it was bound to destroy irrecoverably the delicate condition of central loading." Subsequently, attention has been directed to the rocker casting and its design, and the evidence has been believed to point to this casting, rather than to a rotation of the girder, as the source of the disaster to the suspended span. After considering the general arrangement of the slings supporting the suspended span, it would seem advisable to ask whether anything else beside the breaking of the rocker casting could have been the cause of the failure.

The upper or transverse pin, supporting the span, was but 2¾ in. below the two lowest pins in the lifting chains, on which rotation of the lifting girder could take place. Had the center of the rocker pin been slightly more than ¼-in. off the centers of the lifting-chain pins just mentioned, the slope of the lower or longitudinal rocker pin would tend to be 5%, which is probably about the angle of friction of the rocker casting on the pin. To insure all three of these pin centers being in a vertical plane, it would be necessary that the workmanship on the lifting girders be accurate; that the lowest castings be bolted to the girders just right longitudinally; that the centering plates be correctly placed, and finally that the girders be in a vertical plane just at the time they received the load. That all these conditions were not obtained when the weight was transferred from the barges to the slings is not outside the range of the probable, and it is likely that initial inexact centering would be aggravated later.

On the excellent photographs of the insert of Sept. 21, there is no sign of a heavy vertical blow on the southwest lifting girder. The most prominent effects are the tear through the hitch angles, which looks as if it were done by a sharp corner of the falling mass dragging through it, and the squeezed-out lead, which proves that there was an eccentric load or a blow; if it were the latter, it was not heavy enough to break the casting. The direction of motion, indicated by the several sheared bolts, might merely indicate motion of rotation of the lifting girder, combined with the vertical motion of the falling mass. It hardly seems positive proof of a broken casting.



PLAN OF ROCKER CASTING, SHOWING DIAGONAL SHEAR

Had the lifting girder been properly braced by a strut to the bottom chord of the suspended span, the equilibrium of the structure would not have depended on friction. It would seem that unnecessarily flexible design might have been the primary cause of the disaster. Would it not have been better to have connected the chains directly to the ends of the span?

Regarding the rocker casting that supported the suspended span of the Quebec Bridge, and the computations recently appearing in your columns for the strength of the section at the center, would it not be well to call attention to some additional points of interest.

The midsection, for which the moment of inertia was figured, has inclined sides and is irregular. As in the case of a circle, the distribution of stress on such a section does not seem to follow the simple law that it does in a rectangular section with vertical sides. A pin, for instance, will resist more bending than the ordinary computation would indicate. In addition, the midsection has on each side of it sections increasing in depth and area. On this account the midsection would probably stand more load, as the circumstances are analogous to the nicked tensile specimen, which will stand a greater stress per square inch than one not nicked. Furthermore, at the middle of the casting there are stresses of opposite kind, in planes at right angles to each other at the top of the casting, the fibers running longitudinally with the span being in compression and those running transversely being in tension. At the bottom of the casting the condition is just the reverse. It would seem a very difficult matter to get stresses actually existing, especially when so many assumptions can be made regarding distribution of the load.

ROBERTS S. FOULDS.

Phoenixville, Penn., Oct. 21, 1916.

Public Health Association Has Model Convention

In striking contrast to some conventions of other societies held this year the forty-fourth annual convention of the American Public Health Association at Cincinnati, Ohio, last week, was a model of how to do it. Although 159 papers and reports were scheduled for presentation in a four-day convention, and although the only business done at the single evening session was the president's address, yet the program was carried out without confusion and with apparently plentiful time for discussion.

This high convention ideal was attained by skillful planning and equally capable execution of the program by men who knew just what was wanted and exactly how to get it. The subjects were live ones and well grouped. Competent men and women were chosen to present them. The sessions opened on time or very nearly so. The presiding officers kept their sessions thoroughly in hand, holding authors and discussers of papers to the set time limits and not only leaving time for free discussion but judiciously stirring it up by calling on this or that person in case the discussion did not move fast enough.

Obviously, 159 papers and reports could never have been presented in four mornings, three afternoons and one evening of business proceedings were not the association divided into sections. These sections include Public Health Administration, Laboratory, Vital Statistics, Sanitary Engineering, Sociological, and Industrial Hygiene, besides which there was a special period devoted to Foods and Drugs and three General Sessions.

The recent marked progress of the association is shown by the rapid increase in membership during the past few years to a present total of 1,647 and a 40% increase in the circulation of the *Journal* to 2,400 copies. Moreover, a *Journal* deficit of $2,800 reported a year ago has given place to a surplus of $30 for the year just closed.

Before passing on to brief mention of a few of the scores of papers and reports it may be noted that the President Elect is Dr. W. A. Evans, not long ago health commissioner of Chicago. Prof. Selskar M. Gunn, of Boston, Mass., will continue as secretary and editor, it is understood. The new chairman of the Sanitary Section is Theo. Horton, Albany, N. Y.; and of the Laboratory Section, Dr. Henry Albert, of Iowa. The 1917 convention will be held in New Orleans.

Substantial contributions were made by a number of committees. Mention will here be made of the reports to the Sanitary Engineering Section, only, except to note that some changes in existing laboratory standards were recommended by the committees on bacterial and on chemical analyses of water and sewage. These changes will come up for action next year.

The Committee on Water Supply, through F. F. Longley, New York City, chairman, called attention to the need for more careful and extended observations on the results of water disinfection—there now being about 600 chlorination plants in use, as compared with 60 at the beginning of 1914.

A carefully devised score system for rating the sanitary condition of public water-supplies was presented by Theo. Horton, and E. S. Chase, Albany, N. Y. H. A. Whittaker, Minneapolis, Minn., submitted statistics showing how necessary it is to have a field survey or sanitary inspection of water-supplies instead of relying upon analyses alone. On this subject Mr. Horton remarked that for three-fourths of the water-supplies a sanitary survey is sufficient.

Fundamental principles and a proposed code were submitted by the Committee on Sanitary Control of Waterways, H. P. Eddy, Boston, chairman. This report was warmly and generally commended. The section voted that not only this but also the other committee reports submitted for adoption by the Section should be sent to the Executive Committee with a request for early printing in the *Journal;* that reprints of the reports be sent to Section members about 30 days before the next ensuing annual meeting, at which the reports should come up for discussion and adoption. The proposed code will be printed in a later issue. In this issue there are given parts of the reports of the Committee on Sewage Works Operation and Maintenance, W. L. Stevenson, Philadelphia, chairman, which was devoted largely to an advocacy of State Board of Health supervision of the operation of sewage works, and of the report of the Committee on Sewerage and Sewage Disposal, Geo. S. Webster, Philadelphia, chairman, which presented a series of definitions of sewerage and sewage disposal terms. These definitions, in full, will go to members of the Section and be presented for action by the section next year. H. P. Eddy thought the states should stop with insisting that sewage works be properly operated, leaving detailed supervision to engineers in private practice. The committee might well define just what it means by state supervision. M. N. Baker, of New York, remarked that the state should say what must be accomplished rather than how. Mr. Stevenson said in closing the discussion that the committee did not intend that the state should usurp the functions of private engineers.

The report of the Committee on Refuse Collection and Disposal, Samuel A. Greeley, Chicago, chairman, mentioned a five-ton garbage reduction plant at Pontiac, Mich. Rudolph Hering, New York City, read a paper discussing at length what sort of contract plans and specifications are needed for obtaining incinerators on a most economical basis. He advised taking into account cost of collection and transportation; that general plans and specifications be prepared by a competent engineer for the city, but that each bidder submit his own detailed plans; and that contract prices be submitted on the basis of annual unit costs of operation, including capital as well as operation charges.

A valuable study of the relation between street cleaning and street dirt and disease was presented by Samuel Whinery, New York City, Chairman of the Committee on Street Cleaning. Some of the main conclusions of this paper are given elsewhere in this issue.

Definitions of Sewerage and Sewage-Disposal Terms

The need for a careful definition of terms used in sewerage and sewage disposal has been growing more and more evident for years past. The Committee on Sewerage and Sewage Disposal of the Sanitary Section of the American Public Health Association, with the coöperation of a dozen eminently qualified sanitary engineers, submitted a long series of definitions to the recent Cincinnati convention of the Association. A few of the least obvious

definitions, or those most likely to arouse differences of opinion, are here quoted from the report:

Drain is a conduit intended to carry storm, surface and ground water.

Separate Sewer is a sewer which is intended to receive only sewage and not storm water or surface water. ("Separate Sewer" is preferable to "Sanitary Sewer," which latter term should be discontinued.)

Sewage Treatment is the process to which sewage is subjected in order to partially remove its impurities and render it fit for final discharge. (The term "Sewage Purification" should be abandoned.)

Contamination is the introduction into a water of bacteria or other substances which tend to render it unsuitable for domestic use.

Pollution is the introduction into a water of substances of such character and in such quantity that they tend to render the body of water or river objectionable in appearance, or to cause it to give off objectionable odors.

Clarification is the removal of the suspended and colloidal matters.

Colloidal Matter is suspended matter which is so finely divided that it is no longer acted on by gravity, and remains suspended indefinitely, yet will not pass through a parchment membrane in the ordinary process of dialysis.

A Screen is a device containing openings of proper size to retain a part of the suspended matter of sewage.

Coarse Screen is one having openings in excess of ½ in. in least dimension.

Fine Screen is one having openings of ½ in., or less, in least dimension.

Bar Screen is one composed of parallel bars or rods.

Mesh Screen is one composed of a fabric, usually of wire.

A Grating consists of two sets of parallel bars in the same plane, the sets intersecting at right angles.

Perforated Plate Screen is one made of perforated plates.

Band Screen is one consisting of an endless band, or belt, which passes over upper and lower rollers.

Wing Screen is one having vanes, uniformly spaced, which rotate on a horizontal axis.

Drum Screen is one in the form of a cylinder or cone, consisting of perforated plates or a wire mesh which rotates on a horizontal axis.

Disk Screen consists of a rotating circular perforated disk, with or without a central truncated cone of similar material mounted on the center.

Cage Screen consists of a cage having three sides made of parallel bars, or rods, so arranged that it may be lowered into the sewage, and raised therefrom for cleaning.

Sedimentation Tank is a tank for the removal of suspended matter either by quiescent settlement or by continuous flow at such a velocity and time of retention as to allow deposition of suspended matter.

Dortmund Tank is a vertical sedimentation tank, usually cylindrical, in which the raw or partially treated sewage enters the lower part, flows upward and passes out near the top. The sludge is drawn before it becomes septic from the conical or hopper-shaped bottom.

Hydrolytic Tank is a tank in which by biological processes a portion of the suspended matter is converted into liquid and gaseous form.

Septic Tank is a horizontal, continuous-flow, one-story sedimentation tank through which sewage is allowed to flow slowly, to permit suspended matter to settle to the bottom, where it is retained until anaerobic decomposition is established, resulting in the changing of some of the suspended organic matter into liquid and gaseous substances and a consequent reduction in the quantity of sludge to be disposed of.

Tarvis Tank is a two-story tank consisting of an upper, or sedimentation chamber, with steeply sloping bottom, terminating in one or more slots through which the solids may slide as deposited into the lower or sludge-digestion chamber, through which a predetermined portion of the sewage is allowed to pass for the purpose of seeding and maintaining bacterial life in the sludge and carrying away decomposition products, thus inducing digestion of the sludge attended by its reduction in volume.

Imhoff, or Emscher, Tank is a two-story tank consisting of an upper, or sedimentation chamber, with steeply sloping bottom, terminating in one or more slots through which the solids may slide as deposited into the lower or sludge-digestion chamber—these slots being trapped so as to prevent the rise of gas and solids from the lower chamber—the lower chamber being provided with vents for the escape of the gases, the tank being so constructed as to facilitate the passage of the sewage quickly through the upper chamber and prevent the flow of sewage through the digestion chamber, and so operated that the sludge may be thoroughly decomposed, rendered practically free from offensive odor and so filled with gas that it can be readily drawn off and dried.

Activated-Sludge Process consists in the agitation of a mixture of sewage with about 15% or more of its volume of bacterially active liquid sludge in the presence of ample atmospheric oxygen, for a sufficient period of time to at least coagulate a large proportion of the colloidal substances, followed by sedimentation adequate for the subsidence of the sludge flocculi; the activated sludge having been previously produced by aeration of successive portions of sewage and maintained in its active condition by adequate aeration by itself or in contact with sewage.

Trickling Filter. (The committee is of the opinion that the term "Trickling Filter" is preferable to the term "Sprinkling Filter" or "Percolating Filter.")

Disinfection is the destruction, by the agency of some chemical, of a large percentage of the bacteria in sewage or contaminated water, so as to reduce the danger of infection to a negligible quantity.

Sterilization is the destruction by the agency of some chemical, of all the bacteria in sewage or contaminated water, including their spores.

Nuisance (in relation to a polluted stream) is a condition which is offensive to the sense of sight or smell.

A Clean River, in regard to sewage, is one which gives no sensuous evidence of sewage pollution and from which a wholesome drinking water can be obtained by practicable methods of water purification.

It should be understood that the report is a preliminary one. The committee wishes full and free discussion from all persons interested. George S. Webster, 550 Bourse Bldg., Philadelphia, is chairman of the committee. The other members who signed the report were Kenneth Allen, New York City, Frank A. Barbour, Boston, and Langdon Pearse, Chicago.

State Board of Health Control of Sewage Works*

For the purpose of this report the 48 state boards of health in the United States have been divided into three groups:

1. Those states whose boards of health have no engineer upon their staff or have no specific legislation giving them control over the disposal of sewage, or have so few sewage-treatment works under their jurisdiction that the subject is negligible. These 24 states in 1910 had a population of over 24,250,000, or 26% of the total population of the United States, and are: Alabama, Arizona, Arkansas, Colorado, Delaware, Georgia, Idaho, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, South Carolina, Tennessee, Utah, Washington, West Virginia, Wyoming.

2. Those states whose boards of health have an engineer or other officer charged with supervision over disposal of sewage, but whose legal powers are limited and the number of sewage-treatment works are small. The officers of this group of states have all signified their willingness to coöperate with your committee and have furnished valuable data. These nine states in 1910 had a population of 12,753,000, or 14% of the total population of the United States, and are: Connecticut, Florida, Indiana, Kentucky, Louisiana, Maine, New Hampshire, North Carolina, Rhode Island, Vermont.

3. The remaining 15 states have boards of health with engineering divisions and either have legal authority or otherwise exercise control over the disposal of sewage and operation of sewage-treatment works. The 1910 popula-

*From report of Committee on Sewage-Works Operation, etc., Sanitary Section, American Public Health Association, presented at Cincinnati, Ohio, Oct. 26, 1916. The members of the committee are: F. E. Daniels, C. A. Emerson, Jr., C. B. Hoover, Richard Messer, W. L. Stevenson, chairman, City Hall, Philadelphia, Penn.

SEWAGE WORKS AND THEIR CONTROL BY 15 STATE BOARDS OR DEPARTMENTS OF HEALTH

State	Officer Furnishing Data: Name	Title	Population of State in 1910	Number of Works in State: Total Number	For Population of: 25 to 500	500 to 10,000	Over 10,000	Number of Works with Laboratory	State Board or Department of Health: Requires Approval of Plans for Sewage Prior to Construction	Exercises Supervision Over Operation	Makes Inspection	Makes Analyses of Sewage and Effluent	Receives Reports of Operation
Calif.	C. G. Gillespie	Chief engineer	2,377,500	100±	Numerous	90	3	.....	Yes	Yes	Occasionally	Yes	Have power; not yet
Ill.	P. Hansen	Chief engineer	5,638,600	75	4	61	10	.....	Yes	Not yet	Not yet	By State Water Survey	Rule passed; not yet
Iowa.	L. Higgins	Sanitary engineer	2,224,800	85	1	82	2	2	Yes	To some extent	Yes	Yes	Yes, after Jan. 1, 1917
Kans.	C. A. Haskins	Chief engineer	1,690,900	67	9	53	5	.....	Yes	Yes	Yes	Yes	Just installed
Md.	R. B. Morse	Chief engineer	1,295,300	13	†	12	1	1	Yes	Yes	Yes	Yes	Not yet
Mass.	X H Goodnough	Chief engineer	3,366,400	58+	34+	11	13	3	Yes	Yes	Yes	Yes	Yes
Mich.	E. D. Rich	State sanitary engineer	2,810,200	38	22	14	2	.....	No	Yes	Yes	Sometimes	Soon
Minn.	H. A. Whittaker	Director	2,075,700	79	44	32	3	.....	No law, but nearly all submit plans	To some extent	Yes	Yes	No
N. J.	C. G. Wigley	Chief bureau of engineer	2,537,200	168*	66	89	13	2	Yes	Yes	Yes	Yes	Soon
N. Y.	T. Horton	Chief engineer	9,113,600	178	73	90	15	.....	Yes	Partial	Yes	Yes	In some instances
Ohio.	W. H. Dittoe	Chief engineer	4,767,100	162	92	64	6	1‡	Yes	Yes	Yes	Yes	No
Penn.	C. A. Emerson, Jr.	Chief engineer	7,665,100	117	61	47	9	17, 32 partial	Yes	Yes	Yes	Yes	Yes
Tex.	V. M. Ehlers	Sanitary engineer	3,896,500	40	2	37	1	2	No law, majority submit plans	Standards required	Yes	Yes	Yes
Va.	R. Messer	Sanitary engineer	2,061,600	44	22	22	0	1	No law, but plans passed on	No law but supervised	Yes	No	No
Wis.	W. G. Kirchoffer	Sanitary engineer	2,333,800	70+	.....	60±	10±	.....	Yes	Yes	Yes	Yes	No
		Totals	1,294	437	764	93							
		%	100	34	59	7							

* Fifteen trade-wastes plants, not included. † Many small institutional plants not included. ‡ Four additional laboratories planned for.

tion in these states was about 54,000,000, or 60% of the total population of the United States.

The conditions in these states are given in the accompany table from which it will be seen that, generally, sewerage plans must be approved before construction; supervision, inspection and analyses are made, and in some states reports of operation are made to the state board of health.

It will be noticed that commonwealths representing more than half the population of the United States have given their state boards of health supervisory powers, but it will be further observed that at the present time only in Massachusetts, Pennsylvania and Texas is the operation of the sewage-treatment works regularly reported to the state officials. Several other states are preparing to inaugurate this means of exercising supervision.

Upon completion of the construction of sewage-treatment works it very frequently happens that the operation is intrusted to persons entirely unfamiliar with the intent and purpose of the designer. It is particularly important that early operation, where adjustment of parts must be made to meet unanticipated conditions, should be intrusted to either the designer or some engineer familiar with all the intricacies of operation. This provision can be met by a requirement in the permit of approval issued by the state for the construction of the works.

The table shows that over one-third of the plants given therein are designed for population of less than 500, over one-half for populations between 500 and 10,000, and only 7% for populations over 10,000.

State supervision should include inspection of the works, analyses of sewage and effluents, and examination of records of operation. With these data the state officials can advise those in charge of the works how to operate them to obtain the optimum results.

Inspections and sampling by the state should be done not at regular intervals, but when critical conditions exist, in order to be familiar with the results obtained at times of maximum load when defects are most noticeable.

Generally, reports should be submitted to the state board of health by all sewage-treatment works. In cases of small domestic or institutional plants it may be felt that there is practically nothing to report. But in such cases, if the owner is required to send a report to the state setting forth the condition of the plant, it is an incentive to at least examine its operation occasionally, which otherwise would be overlooked.

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Errors in Liquid-Measuring Pumps used in the sale of gasoline are exceedingly common, according to a bulletin just issued by the Bureau of Standards. Examinations of measuring pumps of various types, chosen at random in a number of different cities, were made by an inspector of the Bureau of Standards and showed that 70 to 80% of the pumps examined had excessive errors. In nearly all cases these errors consisted in deficient delivery. An approximate estimate indicates that in Illinois alone the loss to purchasers of gasoline, due to short measure, may exceed half a million dollars per annum.

⌘

The Boston Elevated Railway Co. is in need of additional capital for the purchase of rolling stock for the existing rapid-transit lines and also for equipping the Dorchester tunnel and the extension to Everett, now under construction. It is unable to secure this capital from the sale of stock, because under existing laws it cannot sell stock at less than par, and the stock is now selling at 73. It cannot sell additional bonds, since the law limits its bond issues to the amount of stock outstanding, and it is already up to that limit. A special board created by the legislature of 1916, consisting of the Massachusetts Public Service Commission, the Boston Transit Commission and members of the Senate and House, is holding hearings in Boston, beginning on Sept. 25, to consider means of extending relief to the company. The testimony thus far presented shows that the company's present financial condition is due principally to increased cost of labor and material and the enormous increase in the company's investment on which fixed charges must be met, this increase being at a much greater rate than the growth of its traffic.

Permanent investments in the Boston Elevated system on June 30, 1916, amounted to $116,000,000, which is 4½ times as great as in 1907. The number of paying passengers has only doubled in the same time. Further than this, the increasing length of the average journey in connection with the free transfer system has prevented the revenue from increasing in proportion to the service rendered. The proposals which the board is considering for the company's relief include the following:

1. An increase in the rate of fare.
2. The adoption of the so-called zone system of fares.
3. Charging for transfers.
4. Establishment of inclosed areas at transfer points where practicable, so as to reduce the number of paper transfers.
5. Elimination of the 8c. check.
6. Purchase of the Cambridge subway by the state and its rental to the company.
7. Temporarily charging off depreciation against premiums paid in on stock and bonds.
8. Return of the $500,000 deposited with the state, so that it will be available for ordinary capital purposes.
9. Reimbursement for subway rentals.

The Cantilever Bridge at Cernavoda, Roumania

Probably the largest bridge that has thus far suffered destruction in the European War is the great cantilever bridge at Cernavoda, Roumania, which was wrecked by the retreating Roumanian army on Oct. 26. The bridge was completed and formally opened for traffic 20 years ago and was, so far as we are aware, the longest span cantilever bridge in continental Europe.

A full description of the bridge was published at the time of its completion, in *Engineering News* of Aug. 27, 1896. We reproduce from that issue the accompanying photograph showing the bridge partly completed, with a side elevation of the structure and a cross-section making clear the extreme batter of the trusses. The photographic view also makes evident the unusual plan adopted for the erection of the structure. The main cantilever spans were erected when the piers were only a short distance above the water level, and the spans were raised by hydraulic jacks as the piers themselves were built up until they reached their final elevation.

FIG. 1. VIEW OF THE CERNAVODA BRIDGE OVER THE DANUBE UNDER CONSTRUCTION
(Two main cantilever spans completed and piers supporting them under construction)

The bridge was built by the Roumanian Government, and nearly 5½ years were occupied in its construction. Some of the chief features of interest with respect to the structure, as printed in *Engineering News* 20 years ago, are as follows:

At the point on the river where Cernavoda is located, and where it was determined to place the bridge, the Danube is divided into two branches by the island Balta. The river flows in a northerly direction at this point, and it is the easterly channel that retains the name of Danube, the westerly being called the Borcea River. The island is swampy, and at certain times is entirely covered with water. It is between seven and eight miles in width. Two bridges are thus necessitated, and on the island a long stretch of embankment with an open viaduct about halfway across.

The total length of iron structure is about 13,460 ft., or 2.6 mi., this being divided as follows: Cernavoda bridge, 2,460 ft.; approaches to Cernavoda bridge, 3,000 ft.; viaduct on Balta island, 4,770 ft.; Borcea bridge, 1,380 ft.; and approaches to last named, 1,840 ft. The first two mentioned portions may be seen in Fig. 1, showing the Danube bridge in course of construction. The piers for the 15 spans of the approach lead away westward to the end of the embankment in the distance.

The contract for the construction of the Cernavoda bridge, not including approaches, was awarded to the Société de Fives-Lille, of France, for $1,570,000. This estimate was based on a rate for the superstructure of $135.40 per ton weight, including erecting and painting. The estimated weight was 5,150 tons; the actual is about 5,500.

The construction of the river piers was attended with unusual difficulties. It was required that they be built on bedrock, and to accomplish this it was necessary to sink the caissons to a depth of 101 ft. below water level. Much difficulty was experienced in working at this great depth, the extreme pressure proving fatal to a number of laborers. The total height of the pier is 207 ft., giving the floor of the bridge an elevation of 121 ft. above high-water level.

There are four river piers, each two supporting a span 790 ft. long, consisting of two end cantilevers, each 164 ft. in length, and a central truss construction. The spaces remaining are filled with three 295-ft. truss spans, having half-parabolic top chords. An elevation of the bridge, showing length of various parts, is given in Fig. 2. The width of the bridge at the floor level varies from 29 ft. at the piers to 21 ft. at the ends of the cantilevers. These widths are maintained throughout the 467-ft. and the 295-ft. portions. Fig. 3 is the end elevation of the superstructure at a pier. One of the most noticeable features of the construction, the rapid narrowing from bottom to top chords, is here shown. The slope of the trusses is 1:10 with the vertical. Basic open-hearth steel of a tensile strength of from 59,000 to 68,000 lb. per sq.in. is used in the main bridge. The elongation at failure in tests of this steel was about 20%, and the elastic limit was about 34,000 lb. per sq.in. On the approaches a milder grade of steel was used.

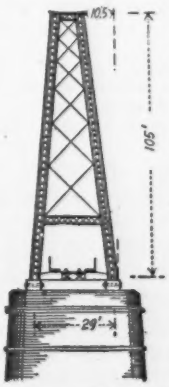

FIG. 3. SHOWING INCLINATION OF TRUSSES

The two main spans of the superstructure, as shown in Fig. 1, were erected at the same time with the piers themselves. They were first lifted by trestles to high-water level. From that point they were raised by hydraulic jacks on the piers. The jacks were supported on pipes embedded in the masonry of the piers, there being four pipes in each pier, used in pairs. While one pair was being extended, the other supported the weight of the jacks. In this way ample space for working at the top of the piers was obtained. The bridge is crossed by but a single track.

The approaches and viaduct present no features of particular interest, except, per-

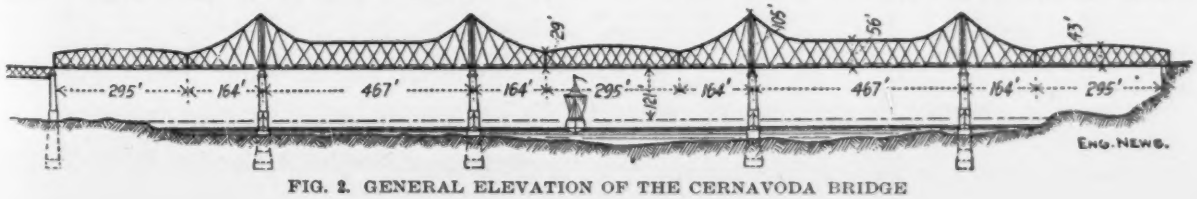

FIG. 2. GENERAL ELEVATION OF THE CERNAVODA BRIDGE

haps, the solidity and permanency of construction prevailing throughout. The masonry piers are surmounted by trusses of ordinary type. The embankment is built in a substantial manner, with a generous use of riprap.

The Borcea bridge is similar in appearance to the larger structure. It has but two river piers, which support a 790-ft. span like the central spans of the Cernavoda bridge, and connection to shore is made by two 295-ft. half-parabolic spans, as before. The bridge floor is 62 ft. above high-water level.

The total cost of the work, including both bridges and all approaches, was, in round numbers, $6,000,000.

How the Engineer Should Use the Technical Journal

By R. Fleming*

Upon graduation every engineer should subscribe for an engineering journal, or two if he can afford them. It is always best to have one's own copy. More careful attention will be given to the subject matter than if the copy is borrowed, or read hastily in a public library. Any man will lose ground who does not keep in touch with the current events of his profession. It is the "growing" engineer who takes a technical paper. The engineer who is not growing has but little use for one.

The engineering journal furnishes a graduate course in engineering. The application of the laws of mechanics may be seen even in articles that are purely descriptive. In technical articles a wider range is given to fundamental laws. For example, Newton's three laws of motion have been carried to fields undreamed of by the great philosopher.

An analysis of the contents of a number of *Engineering News* shows 48 to 56 pages devoted to technical and descriptive articles, book reviews, personals and similar items, 16 pages of construction news and 100 pages or more of advertisements. The growing engineer does not confine his reading to subjects that affect him directly. He may be vitally interested in the strength of steel compression members, but this does not prevent him from reading papers on dam failures or the artificial disposal of sewage. If he has to deal with contracting, he will give special attention to construction news. An editor of a well-known engineering paper writes:

> It is hardly necessary to point out that if magazines did not have advertisers the technical journal, as we know it today, could not exist. It costs from $12 to $17 per annum to send a high-class technical journal to a subscriber, yet he pays but $3 or $5 for it. From $9 to $12 must therefore be taken from the advertising revenue and paid out in expenses for each subscriber on the list.

That the advertising pages are indispensable to the subscriber interested in buying and selling goes without saying. The general reader makes a mistake if he supposes that they are without value to him. He should occasionally read them from cover to cover. It is significant that in the best technical libraries the portions devoted to advertisements are bound in separate volumes and given a permanent place on the shelves. Advertising today is educational. Witness the following from the weekly page of a national advertiser:

> But friction represents a curious paradox in the various fields of engineering and mechanics. It is at once essential to efficiency and opposed to it. Practically all applications of power depend finally upon friction; also all power applications are subject to serious losses due to friction.

Industrial processes often first become known through the advertising columns. The technical paper or article follows, and finally the description is embodied in text-books. Publishers announce their new books in the advertising columns. These announcements with the book reviews are often neglected by engineers. Here are two quotations applicable to engineers "too busy to read" and others "too poor to buy" books and periodicals:

> The busier the engineer or the leaner his pocket-book the greater the need that he should know just what is the newest and the best in engineering literature.
>
> . . . . . .
>
> Are you too busy to read? Seriously ask yourself: Am I? If you are, then you have cut off almost every road to further knowledge and power save such narrow pathways as you may laboriously hack for yourself, unaided, through the jungle of ignorance.

What use shall be made of the technical journal after it has been read? The obvious answer for an engineer taking but one or two papers is to have each volume bound for his reference library as soon as the index is published. In addition, he should have a system of indexing or recording information. In this way he may make subservient to him books and papers that he does not own. If he has access to large libraries, he is baffled by the mass of engineering literature that confronts him. Real value can be derived therefrom only by a process of elimination and a judicious system of note-taking. Davies, in his "Engineering Office Systems and Methods," says:

> The author has many times sincerely wished that, in addition to the usual graduation exorcisms to honesty, hard work, etc., he had at that time been introduced to the loose-leaf method of keeping engineering data and sketches.

While the pleasure of an hour or two of desultory reading among a score of periodicals is admitted, much trouble and after-search will be saved if notes are made on the spot. An abstract from an article should be as brief as possible. Often the title is sufficient. In all cases care should be taken that the authority, with name and date of publication, is copied correctly.

Many systems of filing and indexing information fail because they undertake too much. The card index, so indispensable to office and library, is seldom adapted to the needs of the individual engineer. For a general index of technical periodicals attention is called to "The Industrial Arts Index," covering a wide range of subjects in an excellent manner.

Marketing Engineering Ability*

By C. F. Harding†

The engineer has been freely criticized as "narrow." It is said that he is unable to discuss subjects that do not immediately pertain to his profession. His estimates and recommendations are often considered as impractical by the business man who is seeking engineering advice. In correspondence and upon the witness stand, his statements are said to be too academic and involved.

Engineering ability *per se* is not to be seriously criticized, but rather the marketing of that training in the public mart of twentieth-century demands. The average young engineer of today has the latent technical ability, but lacks the wherewithal to provide that ability with the handle that the layman, the business manager and the town council must necessarily grasp if the engineer-

*American Bridge Co., 30 Church St., New York City.

*Abstract of a paper read before the American Association of Engineers, at Chicago, Oct. 6.

†Professor of Electrical Engineering, Purdue University, Lafayette, Ind.

ing profession is to be elevated to the position occupied in the public mind by the physician and the lawyer.

It will be granted that the average engineer is technically well trained. The employer and the public, however, justly demand more than this relatively small portion of the qualifications necessary for engineering success. The importance of such qualities as good habits, self-reliance, industry, honesty, punctuality, initiative, system, popularity, etc., might be considered at considerable length. The object is not solely to secure more salary, for success and enjoyment of life are not measured in dollars and cents alone.

How is this bond between the engineer and the employer or the public to be strengthened? First, it may be said, convince the young engineer of the importance of good written English and the necessity of clear and concise verbal presentation of his recommendations to a nontechnical individual or audience. If an illustration of this need were called for, the following clause taken from an architect's specifications applying to a building of considerable value would suffice:

Material and Workmanship—The entire framework, columns, beams, etc., as indicated by the framing plans, or as specified, is to be of wrought steel, of quality as hereinafter designated, all materials to be provided and put in place by this contractor. All work to be done in a neat and skillful manner, and is to guarantee the construction and workmanship with a bond equal to amount of tender for a term of five years, satisfactory to the proprietor and architects, to properly carry or support the loads it is designated to carry, namely its whole weight, the weight of the several floors, roof and walls resting thereon, a 10,000 gravity tank, and the pressure of any wind which may not be designated a hurricane, and future three stories.

The engineer should acquire knowledge of business principles, with which his audience is too often more conversant than himself. Who shall interpret into the language of dollars and cents the estimates and findings of the engineer? Can anyone but him analyze as intelligently the valuations upon which the corporation is to base its rate schedules? Surely, no one will question the justification of such a one suggesting to commission or court the fair and equitable gross income that should be allowed a railway corporation in order that it may pay a reasonable dividend upon its stock, when he is perhaps more conversant than anyone else with the construction, operating problems and costs of the particular utility in question. But the average young engineer knows little or nothing about rates, dividends, capitalization, stocks, bonds, etc. And what is worse, many consider it none of their affair.

An estimate of the cost of an engineering project often forms the connecting link between the business world and the engineer. The business manager, the banker, courts and commissions judge the engineer by that portion of his work with which they are familiar—that is, estimated cost of construction, court testimony or appraisals of property. One commissioner severely criticized the engineering profession in general, because two or three engineers varied by a margin of 10% upon a $7,000,000 appraisal in which "going value" entered as a large factor. He argued that engineering was an exact science, and that unless the estimates of engineers could be made as exact as the science they represent the profession was at fault. This example is quoted to indicate the basis upon which the profession as a whole is often falsely judged. Engineering was in this case shorn of its art, and the important element of personal experience behind the judgment of able engineers was left out of consideration. Accounting practice and the proper treatment of depreciation reserves should be matters of common knowledge to the engineer.

Business knowledge, however, even when coupled with a command of one's mother tongue, would fall short of the market demands upon the engineer without the necessary tact that must be exercised in all relations with the public. In a recent investigation made by a subcommittee of the National Electric Light Association the following significant statement was submitted by one of the prominent managers of the West:

Tact is one of the most important things in the public-utility business today, if not the most important. Tact and the habit of accurate thinking are essential, and we must add to these a good allowance of energy. My observations in the whole Northwest lead me to believe that most of the executive failures in this part of the country were due to lack of tact, and also to lack of ability to think rapidly. A technical graduate is too often inclined to follow strictly the letter of the law. This is because he has to deal so much with absolute natural laws which could not be tinkered with, whereas the executive and the commercial men have to deal with human beings, who as far as I can discover, do not follow any laws at all.

The executive quite often fills the gap between the engineering department and the board of directors or the public. He acts as the buffer to receive the rough edges of the average engineering report, and to polish its surfaces that they may make better contact with the layman and the financier. Unfortunately he must frequently stand upon the fence picking the rough burrs from the tree of scientific investigation, which he must laboriously open before the tender kernels of opportunity for investment are disclosed. The term "executive ability" has come to mean "marketing ability" in many corporations. It is a comprehensive quality involving many of the factors previously discussed.

George Westinghouse was an engineer, first, last and always. There are many such in executive offices in this day. The number is rapidly increasing. Whereas we may grant for the sake of argument the claim of skeptics that executive ability is born and not made, it must be admitted that such a quality is often latent and lies dormant for years in many a human system.

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Light-Excluding Effect of Plate Girders—The question of the comparative light-excluding effect of lattice girders and plate girders in elevated-railway construction has been the subject of considerable controversy in connection with the third-tracking of elevated lines in Brooklyn (New York). The easterly half of the Fulton St. line was reconstructed a year ago with plate girders for both transverse and longitudinal supporting members to accommodate the third track. When drawings were submitted by the railroad company for the westerly or downtown portion of Fulton St., showing a similar type of construction, considerable objection was raised by property holders because of the amount of light and air which the proposed construction would exclude from the important stores which line this thoroughfare. The new three-track structure will be considerably wider than the present one and will require much heavier girders than the present girders, which are of the lattice type. The railroad company failing to obtain the approval of the Public Service Commission for the plate-girder design has now submitted drawings showing transverse girders of a combination type. These girders have a central portion about 22 ft. in length with lattice web members, while at each end is a web plate about 12 ft. in length. The loads on these girders are such that the end members of a full lattice girder would require very large connection plates, which would exclude practically as much light as a web plate. The Chief Engineer of the Public Service Commission has approved this type of girder, and Commissioner Henry W. Hodge has recommended approval by the Commission.

News of the Engineering World

Hopple Street Viaduct Open

The Hopple St. viaduct, Cincinnati, Ohio, consisting of reinforced-concrete cantilevers supported on 26 sets of concrete piers, is now open for traffic and will be completed as soon as the electric-lighting system is installed. All piers are on a skew to the center line of the structure, and each one independently supports two balanced cantilevers. The total length of the viaduct proper is 1,930 ft., and with the approaches approximately 2,600 ft. It provides a direct connection between Camp Washington and Fairmount, eliminating grade crossing for the Cincinnati, Hamilton & Dayton, the Baltimore & Ohio and Big Four railroads as well as providing a bridge over Mill Creek. In times of high water due to Ohio River floods all street traffic between the eastern and western hills can be routed over this structure. The total cost is about $430,000, of which amount the city will pay 66⅔% and the railroads 33⅓%. The construction work was done by the Kirchner Construction Co., Cincinnati. The superintendence of the work for the city was by Frank L. Raschig, principal assistant engineer, and F. S. Krug, chief engineer; and for the Baltimore & Ohio R.R. by A. M. Kinsman, engineer of construction, and C. W. Millholland, resident engineer.

Concrete Symposium at Meeting of Albany Engineers

The Albany Society of Civil Engineers conducted a symposium on concrete on the general subject of "Present Day Concrete Practice, or Safety First in Concrete," on Oct. 24, under the leadership of R. S. Greenman. Concrete aggregates were discussed by D. A. Watt, Assistant Engineer, U. S. Engineer Department, who stated among other things that hardness of stone is not so important for mass concrete, giving several examples where soft rock and even shale has been used successfully in concrete piers. He preferred gravel to stone. The matter of using both gravel and broken stone in the same concrete was brought up, the opinion being that such practice was permissible. Joseph Ripley, Consulting Engineer to the State Engineer, discussed various methods of placing concrete, with special regard to chuting. He stated that the slope of chutes on the Barge Canal work was 1 on 1½, maximum length being 700 ft. When the slope is too steep segregation results. With a flat slope there is too much water. Attention was called to the fact that some contractors are slow to move the spout in the forms, preferring to run the concrete to one end of the form and throw the soft material toward the other end. This, of course, is a matter for the inspector to adjust.

H. S. Mattimore, First Assistant Engineer, State Highway Commission, discussed concrete roadwork. The state built its first concrete road in 1912. This was a 1:2½:5 mix, and the maintenance cost has been $1,000 per mile per year. At the present time a first-class concrete road costs to maintain only $129 per mile per year. Of course, a rigid road requires a rigid shoulder, and a large part of the maintenance work is done on the shoulders.

Before placing concrete on an old macadam road, the practice is to scarify the old road and re-roll it. The concrete roads of New York are 7 in. thick in the center and 5¾ in. at the sides.

G. T. Murphy discussed concrete in buildings, choosing "Inspection" as his text. He maintained that cities should provide inspectors to watch the placing of concrete for private buildings. In reply the city engineer suggested that it was up to the architect and owner to provide adequate inspection.

Mr. Greenman's subject was concrete fads, the greatest of which appeared to be waterproofing. He called attention to the necessity for exercising stringent care in selecting the aggregates, and repeated what is now generally accepted, that hydrated lime in proportions of from 8 to 10% by weight makes a smoother flowing and a denser concrete. He stated his belief in the possibility of making too rich a mix.

Texas Engineers Discuss License Law*

The most important subject considered at the annual meeting of the Texas Association of Members of the American Society of Civil Engineers, held at Dallas, Tex., Oct. 20 and 21, was the proposal to license civil engineers in the State of Texas. About 40 members and as many engineer guests were present.

The subject of licensing Texas engineers has been under study and investigation for the past 18 months by a committee of the Texas Association, of which J. M. Howe is chairman. The report of this committee covered the investigations of the workings of similar license laws in Louisiana and Wyoming and the architects' law in Illinois, the activities of the Texas architects for a proposed architects' license law, as affecting the practice of structural engineers and designers of buildings for engineering purposes, together with a draft of a proposed license law as drawn by the committee.

The proposed Texas license law provides for licensing surveyors and engineers separately under distinct qualification requirements, provides for a Board of Examiners with authority to revoke licenses for cause, and provides for temporary licenses without examination for qualified engineers from without the state, together with penalties as a means of enforcing the law.

A number of letters were presented, which had been sent in response to inquiries from local members by engineers in the North familiar with the discussion and investigations made on the subject by the American Society of Civil Engineers. The discussion brought a lively debate as to the advisability of the proposed law.

*Contributed by Terrell Bartlett, of Bartlett & Ranney, San Antonio, Tex.

The sense of the meeting was unanimous that some method should be found for eliminating the impostor engineer with the public loss and injury to the profession resulting from his operations. As to the efficacy of the proposed law to this end there was sharp division of opinion. There was no apparent advocacy of the law for the purpose of making a close corporation of the engineering profession of the state. There was an expressed feeling that no legislation should be attempted unless the engineers of the state were fairly unanimous as to its desirability and character.

A motion by John B. Hawley, a director of the American Society of Civil Engineers, indorsing the proposed law and voting the committee plenary powers to carry on negotiations for the legislation was lost by a close vote. The final action taken authorized the committee to continue its investigations, and to ascertain further the sentiment of all engineers in the state on the subject of licensing engineers.

Completion of Calcasieu River Bridge; Lake Charles, La.

There was recently completed over the Calcasieu River, near Lake Charles, La., the notable reinforced-concrete bridge shown in the accompanying view. From south to north the bridge comprises one 30-ft. girder span; three arch spans of 96 ft. each (clear); one double-leaf deck plate-girder drawspan of the Strauss trunnion bascule type, 118 ft. c. to c. of main bearings; three arch spans of 96 ft. each; and twenty-eight 30-ft. girder spans. There is a 20-ft. roadway.

The minimum depth of water at the bascule piers is 32 ft. All piers were constructed by the open-caisson method. Each arch span consists of two ribs with spandrel columns supporting the concrete deck. The bascule lifts are operated by two 5-hp. electric motors.

The contractors for the concrete work were the Missouri Valley Bridge and Iron Co., Leavenworth, Kan., and the Fruin-Conlon Contracting Co. The bascule lift drawbridge was fabricated by the Federal Bridge Co., Waukesha, Wis., and erected by the Missouri Valley Bridge and Iron Co. All electrical equipment was designed by C. H. Norwood, electrical engineer, Chicago, Ill. F. H. Franklin, consulting engineer of St. Charles, La., prepared plans and specifications, and had general supervision of construction of the bridge, which was built for the Parish of Calcasieu at a cost of $131,000. It is on the Spanish Trail Highway from New Orleans to Houston, Tex.

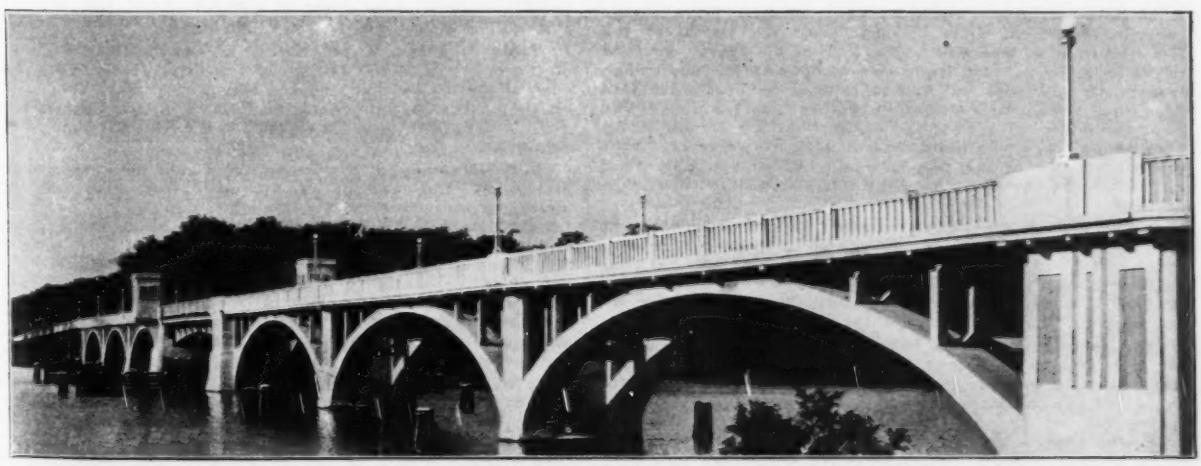
New St. Paul Union Station Plans Approved

On Sept. 28, 1916, the St. Paul Union Depot Co. approved the new plans for a union station at St. Paul, Minn., and authorized the executive committee to proceed with the acquiring of land and the construction work. Plans for this union station, which involved the changing of the Mississippi River channel, were prepared over a year ago, but were vetoed by the Chief of Engineers because of improper provision for navigation requirements. The new scheme does not contemplate any change in the channel.

The revised layout makes it necessary that the Great Northern, the Northern Pacific, the Chicago, Burlington & Quincy, the Chicago, St. Paul, Minneapolis & Omaha and the Chicago, Milwaukee & St. Paul railways turn in considerable land, the basis for which has already been made. Only one piece of private property remains to be taken.

Limit Set to Court Review of Utilities Commission Orders

The New York Court of Appeals has recently rendered a decision of far reaching importance with respect to the powers of a public service commission to control the operations of the companies under its jurisdiction. The commission is given authority under the New York law to direct public service corporations to undertake "reasonable improvements." On Mar. 19, 1915, the Commission for the First District directed a gas company to extend its mains and supply service in certain outlying territory. The gas company appealed to the courts against the enforcement of this decision, contending that the cost would be greater than the financial return would warrant. The Appellate Division upheld the gas company and annulled the order of the commission as unreasonable. This ruling has now been reversed by the Court of Appeals in a unanimous decision. The important point in the decision is



CALCASIEU RIVER BRIDGE NEAR LAKE CHARLES, LA.

the declaration that courts have no right to exercise such administrative powers as those possessed by the Public Service Commission. The court could only annul the commission's order if it found it to be an unreasonable, unlawful, arbitrary, or capricious exercise of power. The court had no authority to go into all the details of the case and practically act as a public service commission of a superior order. The Court of Appeals declared that if the decision of the Appellate Division had been allowed to stand it would "go far toward defeating the efforts of the Legislature to establish agencies to regulate great public service corporations."

Engineers' Advice Not Heeded

Sharp criticism of the Mayor of Cleveland, Ohio, for not following the suggestion of a committee of the Cleveland Engineering Society that engineers be chosen for directors of public service and public utilities was a feature of a recent address before the society by Mayo Fesler, secretary of the local Civic League and secretary to ex-Mayor Newton D. Baker. Mr. Fesler said in part:

The Cleveland Engineering Society, always alive to the best interests of the city, sent the newly elected mayor, Harry L. Davis, a courteous letter offering the most generous coöperation of the society and its members in the improvement of the public service.

In that letter the committee wisely pointed out how much more economically and efficiently the technical service could be performed if men with engineering training and experience were appointed. This was in full accord with the mayor's own statement in his platform and on the stump.

The letter specified particularly the offices of director of public service and director of public utilities as positions that should be filled "by men having broad engineering experience combined with administrative ability."

What did the mayor do? He appointed to the directorship of public service a lawyer whose only training for the office was three terms in the city council and effective political service in both Mayor Davis' mayoralty campaigns.

The directorship of public utilities was given to the secretary of the Federation of Labor, whose training had been that of business agent for the waiters' union.

Immediately under the director of public service are two offices which only engineers can fill satisfactorily and efficiently, the city engineer and the commissioner of streets.

The city engineer, a member of the engineers' society, was not disturbed, but in the new position of commissioner of streets, to which the citizens' street committee, appointed by the Cleveland Automobile Club, had urged the appointment of a competent engineer, the director appointed a horseshoer, a ward leader whose only experience had been a few months' service in the street department under a previous Republican administration.

Highway Bridge Wrecked by Concrete Mixer—The bridge carrying Beale St., Quincy, Mass., over the tracks of the New Haven R.R., was wrecked on Oct. 27 by a large concrete mixer on a flat-car in a train passing beneath it. The bridge was nearly 50 years old and is said to have afforded less headroom than more modern structures on the line. The concrete mixer projected above the box-cars in the train high enough to cause the damage. A 12-in. water pipe that crossed on the bridge was broken. As considerable time elapsed before the water was shut off, the neighborhood was flooded.

A Septic Tank Patent Infringement Suit has been brought against Shelbyville, Ky., by the Cameron Septic Tank Co., Chicago, Ill. Since Shelbyville is a member of the National Septic Process Protective League, the City will be defended by Wallace R. Lane, of Parkinson & Lane, Chicago, attorney for the League. Mr. Lane defended the Knoxville, Iowa, suit.

The Relative Cost of the Different Essentials in road building, according to statistics compiled by the American Highway Association, are given as follows: In the case of 87 gravel roads the grading and drainage averaged 41% and the surfacing 59% of the total cost; in 104 waterbound macadam roads the grading and drainage cost 37% and the surfacing 63%. In 53 bituminous macadam roads these proportions were 27 and 73%. These figures show that more than half the cost of a surfaced road is generally spent for the materials and labor employed in surfacing the graded and drained roadbed.

New Passenger and Freight Terminals for the City of Cincinnati, Ohio, have been definitely decided upon, according to a statement published in the "Cincinnati Enquirer" of Oct. 4. It is stated that the three most important railways entering the city, the New York Central Lines, the Pennsylvania and the Baltimore & Ohio, have agreed upon a tentative site for a passenger terminal that will place the tracks and the station at least 75 ft. above low-water mark, so that operations will not be interrupted even by a record-breaking flood. The plans include reconstruction of the city's freight-terminal facilities as well.

City Operation of Private Gas and Electric Plants has been proposed by the Memphis (Tenn.) Municipal Commission to two local electric companies. The utilities would be allowed annually 6% return and 3% depreciation on appraised value. The Commission made an alternative proposition for the general reduction of local rates, seeking a maximum of 6c. per kw.-hr. for current in place of 10c.; 85 and 80c. per 1,000 cu.ft. for gas in place of $1; and lower prices for street lighting. The companies have made a counter proposal for rate adjustment after appraisal. The city some time ago authorized the issue of $1,500,000, bonds for a municipal electric plant, and these bonds have now been advertised for sale on Nov. 14. The Commission has employed F. W. Ballard, of Cleveland, as its engineer, and has asked him to select a site for a municipal station.

PERSONALS

F. T. Cadmus has resigned as Manager of the Ambridge plant of the American Bridge Co. to become Manager of the Pottstown plant of the McClintic-Marshall Co.

George B. Gascoigne, Assoc. M. Am. Soc. C. E., Assistant Engineer of the city engineering staff of Cleveland, Ohio, has been appointed Sanitary Engineer at a salary of $2,400 per annum.

T. J. Turk, Chief Engineer of the Inter-State Motor Co., Muncie, Ind., has been appointed Assistant General Manager of the company. He is a mechanical-engineering graduate of the University of Michigan.

Myron E. Fuller, recently with George W. Fuller, Consulting Engineer, New York City, has accepted a position with the engineering staff of the City of Philadelphia, Penn., in connection with proposed sewage-disposal works.

C. P. Collins, Assoc. M. Am. Soc. C. E., has resigned as Sanitary Engineer of Johnstown, Penn., together with four members of his staff, as a result of friction between the City Department of Sanitary Engineering and the City Engineering Department.

William A. Duff, Assoc. M. Can. Soc. C. E., Engineer of Bridges of the Canadian Government Ry., at Moncton, N. B., has been promoted to be Assistant Chief Engineer. He will have the duties of both Engineer of Bridges and Engineer in charge of the Halifax ocean terminals.

John H. Bringhurst, Assoc. M. Am. Soc. C. E., has resigned as Instructor in Civil Engineering at the University of Michigan to become Associate in Civil Engineering at Johns Hopkins University under Prof. C. J. Tilden. Mr. Bringhurst is a graduate of the University of Michigan.

Alfred D. Flinn, M. Am. Soc. C. E., Deputy Chief Engineer of the Board of Water-Supply of the City of New York, has been appointed Secretary of the Mayor's Advisory Committee on the extension courses of the College of the City of New York, which have been organized for the benefit of municipal employees.

C. C. Harshman, of San Francisco, who is the author of the article on "Obsolescence in Appraisals for Rate Making," appearing elsewhere in this issue, is a graduate of the Electrical Engineering Department of the University of California and has been valuation engineer on the staff of H. T. Cory, of San Francisco, since September, 1914. In this position he has had chief responsibility in connection with the valuation of some of the principal public utilities of California, notably the Los Angeles Gas and Electric Corporation, with a valuation of $16,000,000, the People's Water Co., $16,000,000 and the Mount Whitney Power and Electric Co., $4,000,000.

L. W. Baldwin, General Manager of the Central of Georgia Ry., has been elected a Vice-President of the railway company. He was graduated from Lehigh University in 1896 and began his engineering experience as a chairman on the Illinois Central R.R. in July of the same year. He was in the engineering and maintenance-of-way departments until 1904.

when he became a trainmaster. After being promoted in the operating department to the position of Division Superintendent, he returned to the engineering corps as Engineer of Maintenance-of-Way. But three years later he again became Division Superintendent and in January, 1915, became General Superintendent of the southern lines of the Illinois Central R.R. at New Orleans. Since November, 1915, he has been General Manager of the Central of Georgia Ry.

OBITUARY

Samuel Brown, for 30 years Superintendent of Erection for the T. H. Brooks Co., Building Contractors, Cleveland, Ohio, died Oct. 14. He had charge of construction of several Cleveland skyscrapers.

Robert Edgar Noyes, M. Am. Inst. E. E., former Instructor in Electrical Engineering at Pratt Institute, Brooklyn, N. Y., died Oct. 24 at his home in Pittsfield, Mass., from infantile paralysis (acute anterior poliomyelitis). He was born in Crowell, Neb., Dec. 14, 1879. He is survived by a widow and two young daughters.

Charles W. Hotchkiss, M. Am. Soc. C. E., Chairman of the Board of Directors of the Virginian Ry., President of the Richmond Light and Railroad Co. of Staten Island, New York, and widely known in the railway and financial fields, died Oct. 29, at Battle Creek, Mich. He was born in Unadilla Forks, N. Y., June 17, 1863. His engineering experience began at 18 years of age as a rodman on the New York, West Shore & Buffalo R.R. Subsequently he was for 10 years Assistant Engineer of the Michigan Central R.R. From this position he was promoted in 1896 to that of Chief Engineer of the Chicago Junction Ry. From 1899 to 1900 he was Chief Engineer of the Chicago Transfer and Clearing Co. For the following five years he was President of the Indiana Harbor R.R., then General Manager of the Chicago, Indiana & Southern R.R. In 1912 he was elected President of the Chicago Tunnel Co. Mr. Hotchkiss moved from Chicago to New York in 1913, when he was elected President of the Rail Joint Co. of America. He was a member of the Western Society of Engineers, the American Railway Engineering Association, the Engineers Club of New York and other clubs in Chicago and New York.

Theodore Newell Ely, M. Am. Soc. C. E., formerly Chief of Motive Power of the entire Pennsylvania R.R. system, died Oct. 29 at his home at Bryn Mawr, Penn, He was born at Watertown, N. Y., June 23, 1846. He was graduated from Rensselaer Polytechnic Institute in 1866 and was employed at the Fort Pitt foundry at Pittsburgh, Penn. His railway experience began in 1868 with the engineering department of the Pittsburgh, Fort Wayne & Chicago Ry., at Pittsburgh, Penn. Soon after he was appointed Assistant Engineer of the Philadelphia & Erie division of the Pennsylvania R.R. He was promoted to be Superintendent in 1869 and Assistant General Superintendent in 1870. Three years later he was appointed Superintendent of Motive Power of the Philadelphia & Erie division and from then on his rise to the head of the motive power department of the entire system was steady and continuous. He was Chief of Motive Power of the Pennsylvania R.R. lines east and west of Pittsburgh for 18 years—1893 to 1911. He was then retired on a well-earned pension. Mr. Ely was a member of the American Society of Mechanical Engineers, the Institution of Civil Engineers (Great Britain), the American Institute of Mining Engineers, the Franklin Institute and many other learned and scientific societies. He was President of the Eastern Railroad Association and was a member of the permanent commission of the International Railway Congress. He received the honorary degree of Master of Arts at Yale University in 1897 and that of Doctor of Science at Hamilton College in 1904.

ENGINEERING SOCIETIES

AMERICAN MINING CONGRESS.
Nov. 13. In Chicago, Secy., J. F. Callbreath, Munsey Bldg., Washington, D. C.

AERO CLUB OF AMERICA.
Nov. 13. Annual meeting in New York City. Secy., Wm. Hawley, 297 Madison Ave., New York City.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Nov. 13-18. Convention in Atlantic City, N. J. Secy., Louis Stotz, 61 Broadway, New York City.

RICHMOND RAILROAD CLUB.
Nov. 13. Annual meeting. Secy., F. O. Robinson.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ELECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H. Roth, 1410 W. Adams St., Chicago.

KANSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

CITY MANAGERS' ASSOCIATION.
Nov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y.

NATIONAL MUNICIPAL LEAGUE.
Nov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The National Builders' Supply Association will hold its annual meeting at the Hotel Sherman, Chicago, Feb. 12-13. The secretary is L. F. Desmond, 1211 Chamber of Commerce, Chicago.

The Tenth Chicago Cement Show will be held in the Coliseum Feb. 7 to 15, under the management of the Cement Products Exhibition Co. (Blaine F. Smith), 210 So. La Salle St., Chicago.

The American Concrete Institute will hold its annual meeting coincidently with the Cement Show, at the Hotel La Salle, Feb. 8 to 10. The secretary is Harold D. Hynds, 1418 Walnut St., Philadelphia.

The Illinois Lumber and Builders' Supply Dealers' Association will hold its annual meeting at the Hotel Sherman, Chicago, Feb. 14 to 16. The secretary is Geo. W. Jones, 431 South Dearborn St., Chicago.

The Municipal Engineers of the City of New York will hold their 14th annual dinner at the Hotel McAlpin, on Saturday, Nov. 25, at 7 p.m. Tickets sell for $3 each. C. S. Bell is Chairman of the House Committee.

The Alabama Technical Association was formally organized at a recent meeting in Birmingham. The association will include the members of the five national engineering societies. The movement for state organization, according to local press dispatches, was started by H. S. Geismer, Frank H. Crockard, S. H. Lewis, Martin J. Lide, Julian Kendrick, H. M. Gassman, F. G. Cutler, Priestly Toulmin and W. E. Mitchell. The constitution and by-laws have been drawn up and mailed to all members of the national organizations in the state.

The Steel Treating Research Club is the name of a new technical society in Detroit, Mich. Meetings are held in the rooms of the Detroit Engineering Society, 46 West Grand River Ave. The present dues are $6 per year for active members; it is very possible, however, that this rate will be cut in half. An employment exchange is provided for the use of anyone requiring services of men for case-hardening, heat-treating, tool or tool-hardening work, or for chemists and metallurgists. The officers are as follows: President, C. N. Dawe, and the Secretary, H. G. Kiefer.

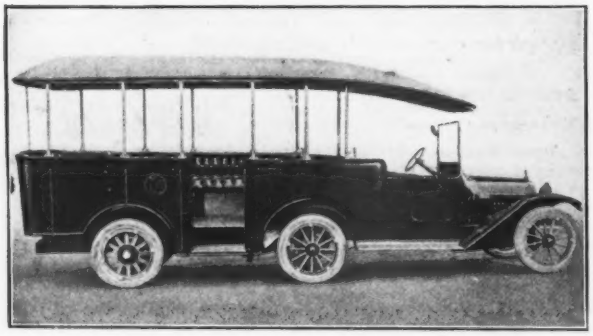
The New England Water-Works Association—The Nominating Committee appointed by President Sullivan met on Oct. 21 and prepared the following list of nominations: For president, Caleb Mills Saville, Hartford, Conn.; for vice-presidents, Carleton E. Davis, Samuel E. Killam, Henry V. Macksey, Frank A. Barbour, Percy R. Sanders, Thomas McKenzie; for treasurer, Lewis M. Bancroft; for advertising agent, George A. King, Taunton, Mass.; for secretary, Willard Kent, Narragansett Pier, R. I. The November meeting will be held in Boston, on Nov. 8, at the Hotel Brunswick.

American Society of Mechanical Engineers—The following officers for 1917 have been nominated by the nominating committee of the society: President, Ira N. Hollis, president of the Worcester Polytechnic Institute, Worcester, Mass.; Vice-Presidents, Charles H. Benjamin, dean of the Schools of Engineering, Purdue University, Lafayette, Ind.; Arthur M. Greene, Jr., professor of mechanical engineering at the Rensselaer Polytechnic Institute, Troy, N. Y.; Charles T. Plunkett, president and secretary of the Berkshire Cotton Manufacturing Co., Adams, Mass.; Managers, Robert H. Fernald, Whitney professor of dynamical engineering, University of Pennsylvania, Philadelphia, Penn.; William B. Gregory, professor of experimental engineering, Tulane University, New Orleans, La.; C. R. Weymouth, chief engineer of Charles C. Moore & Co., San Francisco, Calif.; Treasurer, William H. Wiley, publisher, New York City.

Appliances and Materials

Passenger-Omnibus Trailer

A novel design of trailer-type omnibus has been developed by R. B. Fageol, of San Francisco, and is being exploited by the Fadgl Flexible System, Inc., Hobart Building, San Francisco. One of these "flexible street cars" is shown in the accompanying view—that built for the Pacific Electric Co., of Los Angeles. A trial run of this machine over the Tehachapi Mountains and Mojave Desert (250 mi.) is reported to have



FADGL "FLEXIBLE CAR"

been made in 10½ hr. and at a gasoline consumption of less than 1 gal. per 18 mi. The car was put in regular service by the Fresno Traction Co. in July.

This type of car was designed primarily for use of street-railway companies as a feeder for rail lines. The weight of the bus body is carried largely on the single pair of rear wheels, the forward end being pivoted on any make of car that it is desired to use—even a light Ford. The rear wheels are made to track with the hauling wheels. The body shown seats 15 to 18; a larger size is used for interurban service.

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Self-Propelling Asphalt-Mixing Plant

An asphalt-mixing plant that is portable and self-propelling, to the extent of developing a speed of 1 mi. per hr., has been placed on the market by the Municipal Engineering and Contracting Co., Chicago, Ill. As shown in the accompanying illustration, the machine rests on four steel wheels, the front ones being 40 in. in diameter with 14-in. face, and the rear wheels 48 in. in diameter with 24-in. face. In place of the rear wheels a caterpillar tread may be used. The firebox is built in and forms a part of the main frame. One side is equipped with a furnace for crude oil, the other side with doors and grate bars for burning coal, wood or coke. The drier consists of three drums built into one unit. The largest drum is 68 in. in diameter. Each drum occupies a space 14 ft. by 5 ft. 8 in., and the three are equal to a single continuous drum 4 ft. 3 in. in diameter by 40 ft. long, with 543 sq.ft. of heating surface. The drums revolve at 8 r.p.m. The asphalt-mixing kettle is above the drier and therefore

AUSTIN SELF-PROPELLING ASPHALT PLANT

does not require a separate fire. There are two compartments to the kettle. A fluxing tank large enough to hold a half-day's run can be added, or a detached tank on separate wheels may be used. The measuring boxes are one-half batch capacity and are equipped with standard beam scales. The mixer is of the two-spindle pug type and is gear driven. The mixer discharges into a wagon on the street level, no depressed driveway being necessary.

The machine has an overall length of 34 ft. 9 in., a width of 7 ft. 3 in. and an overall height of 18 ft. 9 in. The traveling height with the elevator taken down is 12 ft. The outfit weighs 26 tons. The capacity is rated at 80 cu.yd. per 8-hr. day in ½-cu.yd. batches. This is equivalent to 1,200 sq.yd. of 2-in. asphalt surfacing. The machine is known as the Austin asphalt mixer and is made by the Municipal Engineering and Contracting Co., Chicago, Ill.

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Protection Against Accidental Reversal of Motor

A new reverse-phase relay is manufactured in both circuit-opening and circuit-closing styles by the General Electric Co. The relay operates on the same principle as the squirrel-cage

A SAFEGUARD WHEN THE ELECTRIC MOTOR REVERSES ACCIDENTALLY

induction motor; the operating coils correspond to stator, and a hollow aluminum cylinder connected to the contacts is analogous to rotor. When a phase is reversed, the plunger operates the contact. These relays are furnished for two-phase or three-phase service.

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Purifier for Lubricating Oil

A new design of purifier or reclaimer for used lubricating oil is being made by the De La Vergne Machine Co., of New York City. The device is in the shape of a double-shell tank, the inner compartment containing the oil and the outer (annular) serving as a hot-water jacket. The cleaning process consists in agitating the old oil with a solution of a special proprietary coagulant, "Oilite." An equal amount of hot water is let into the oil from the jacket, a solution of the coagulant (¼ lb. per gal. of oil) is added, and the contents of the inner tank are agitated by compressed air or a mechanical stirrer. Then the mixture is allowed to settle for 10 hr. The dirt and impurities form a sludge between the clean oil and dirty water. When the connection between inner and outer compartments is opened, the clear oil is automatically discharged.

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Insulating Paint

Two new insulating paints for electrical apparatus are being made by the Union Insulating Co., West Jackson Boulevard, Chicago, under the trade names "Ohmlac" and "Hyblack." They are made from mineral hydrocarbon mined in Utah, called elaterite or wurtzilite. This asphaltic base is combined with nonoxidizing oils and thinned with naphtha. The paints are claimed to be useful also for protection against gases, acids, alkalies and electrolytic action.